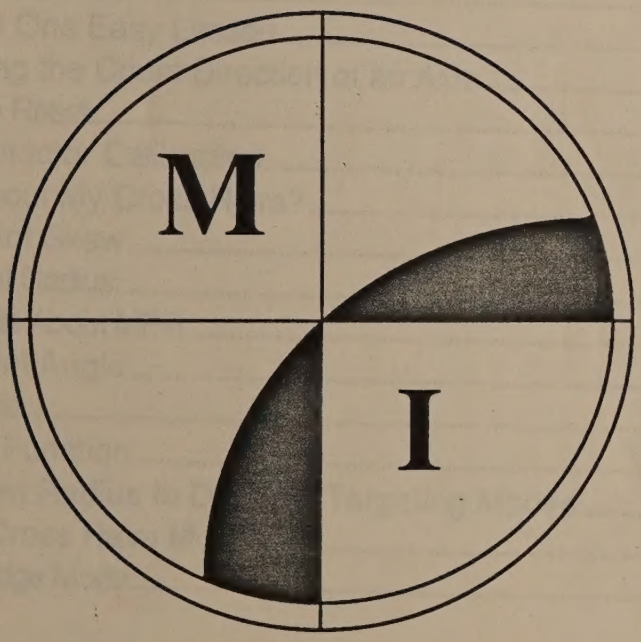
Quadra-Chek III
Operator's Manual



Metronics, Inc.
P.O. Box 5760
Manchester, NH 03108
(603) 622-0212

Table Of Contents

Section One

Introduction 4
Conventions Used In This Manual 5
WARNINGS 5
Front and Back Panel Drawings 6
Measuring With a QC-III 10
About Edge Detection 10
The QC-III's Modes 11
The QC-III In One Easy Lesson 13
- Reversing the Count Direction of an Axis 13
- Axis Zero Reset 14
- Edge Detector Calibration 16
- What About My Cross Hairs? 17
- Multi-Point Skew 19
- Multi-Point Radius 20
- Fine Points About MPR 21
- Multi-Point Angle 22
- Polar Mode 25
- Relative Function 26
- Multi-Point Radius In Different Targeting Modes 28
- MPR in Cross Hairs Mode 28
- MPR in Edge Mode 29

Document No. 11A10018
Manual Version 2.2
8-18-87

Table Of Contents, Continued

Advanced Concepts and Applications

Cancel 31
Preset Operation 32
More About Presets 33
More About Relative 34
More About Polar Measurement 35
Polar Select 36
Establishing a Datum at a Non-Square Corner 37
Memory Operation 38
A Time Saving Hint 39
Part programming 40
Skew On Two Radii 42
Checking for Parallel Lines 43
True Position Tolerance 44
Bolt Circle Calculation 44
Center Line 45
Dist Cal 46
Edit Cal and Print Cal 47
Remote Programmable Keypad 48
Error Messages 49

Set Up Modes, NLEC, and Misc.

Set Up Operation 51
User Set Up 51
- User Set Up Mode Exit 52
- Change Count Direction 52
- Clear All 100 Datum Memory Points 52
- Clear Program Keys 52
- Serial Port Set Up 53
- Enter Dealer Set Up Mode 53

Dealer Set Up 54
- Auto Resolution Set Up 55
- Display Resolution 56
- Linear Error Compensation 57
- Prescaler 58
- NLEC Set Up 58
- Dealer Set Up Mode Exit 58
- Serial Port: RS-232 Pin Out 59
  - Handshake Description 59
  - Input Codes 59
  - Serial Port Output 60
  - Fast Download 61
  - Communications Program 62

Non Linear Error Correction 64
- A note on theory 64
- Before You Begin 65
- NLEC Calibration 67
- Edit Feature 70
- NLEC Report 70

Replacing Fuse 72
Changing Voltage Selection 72
Warranty Information 73
Service 73
Index 74
Auto Resolution Set Up Number 76

Section One

Introduction

This manual comes in three sections. The first (Section One) contains information of interest to everyday hands-on users. The second introduces and explains Advanced Concepts and Applications. The third (Set Up Modes, NLEC, and Misc.) is meant primarily for supervisory personnel and QC-III dealers.

A Note to Dealers and Supervisors

Metronics, Inc. assumes that all Metronics QC-IIIs will be set up for end-users by the dealer. This set up includes calibration according to the user's optical comparator or similar device, and installation of Non-Linear Error Compensation (optional) on the user's comparator.

If the end-user installs a new comparator, then it may become necessary to do everything all over again. In that case, supervisory personnel may want to refer to the Set Up and NLEC sections of this manual. Otherwise, they should contact their original dealer or, failing that, Metronics, Inc.

A Note on Accuracy and Precision

The QC-III is an instrument capable of great accuracy and precision. You may find that the accuracy of the machine's human operators is less than the accuracy the machine is capable of. You may also find that the machine displays measurements to more significant figures than you need. Metronics, Inc. is aware of these discrepancies, but the QC-III is designed for those applications where great accuracy and precision are required.

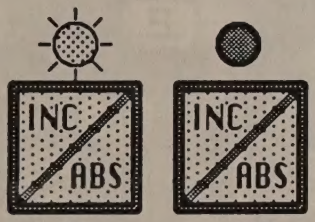
Also, the accuracy of the encoders attached to your comparator is physically limited, as is the accuracy of the QC-III's Edge Detector. All things considered, the QC-III is repeatable to within ±2 encoder counts, or 1 micron, whichever is larger. Therefore, a QC-III attached to 1 micron encoders is repeatable to at least ±2 microns.

Conventions Used In This Manual

It is assumed for all demonstrations that if you move your cross hairs to the right (move the image left) the count increases from 1 to 2 to 3, not from -1 to -2 to -3. The same holds true for the Y axis if you move the cross hairs up (image down) the count increases from 1 to 2 to 3, not from -1 to -2 to -3. If you find that your machine is not reading properly, don't worry. The examples in this manual will tell you how to adjust the count direction to match this convention.

For most examples, the display resolution in this manual will be one ten-thousandths of an inch (0.0001) or two microns metric (0.002). Please note that your QC-III may be set to a different resolution, but don't let this concern you. You don't need to change the display resolution, simply follow the logic of the examples presented.

In the graphic examples, the "on" LED condition is represented by a light circle above the key as shown below on the left. An "off" condition is represented by a darkened circle.

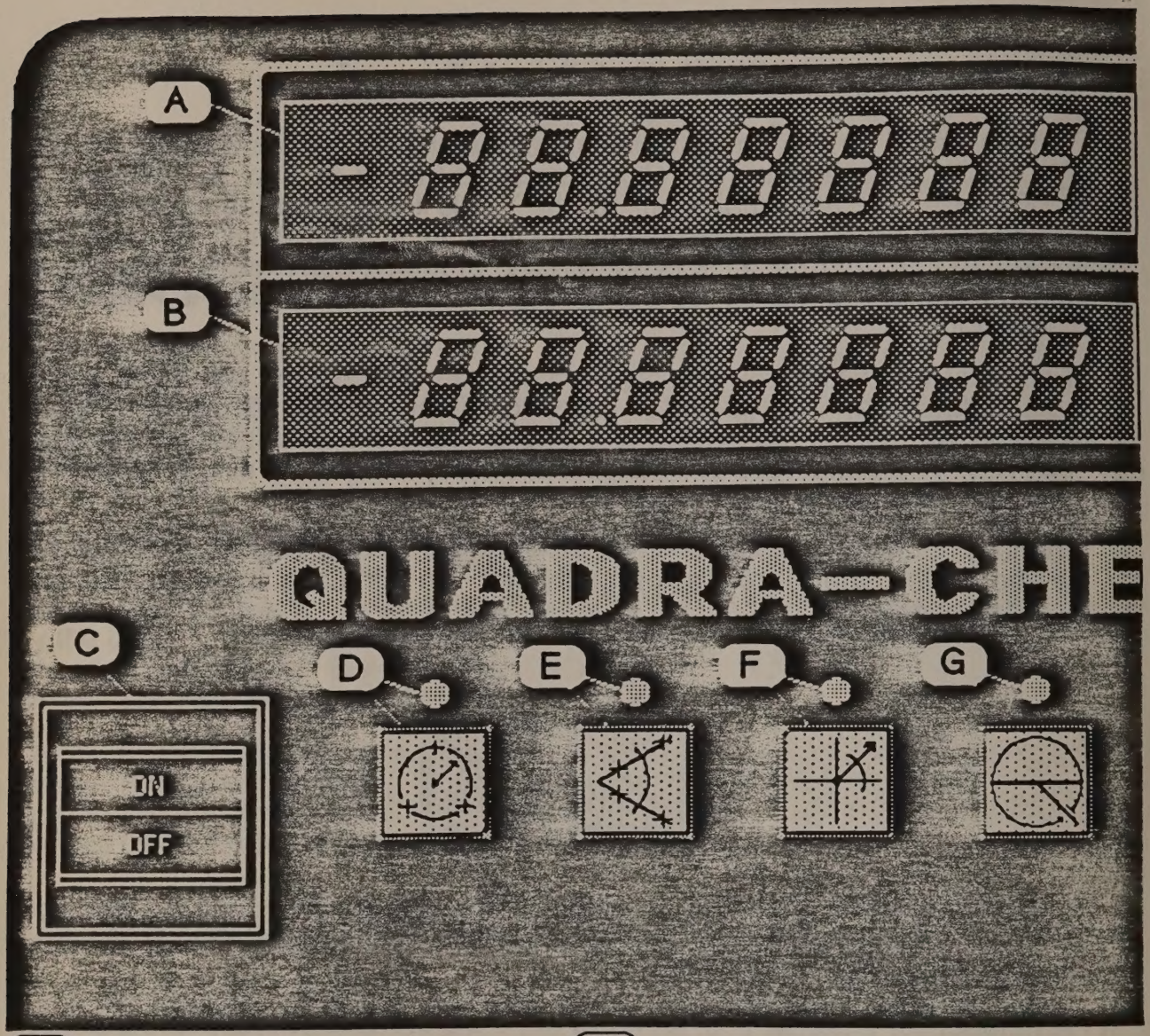


In the illustrations, there may be "optional" keypresses shown. If the indicator light above the key on the QC-III is already in the state shown in the illustration, you won't need to press that key.

A number (or letter) directly below a key's picture tells you to press that key when you reach the indicated step of the directions. For example, a CANCEL key with a "2" under it means that you would press the CANCEL key when you reached step 2 of the directions.

WARNINGS

As explained in the Set Up section, Set Up can be performed entirely from the outside of the QC-III. There is no need to open the QC-III, because there are no user-serviceable parts inside. As with any similar device, the danger of electrical shock exists if the back panel is opened. Please advise your people to refer all maintenance to qualified Metronics service personnel.



(A) X axis display window

(B) Y axis display window

(C) Power switch

(D) Radius key and indicator

(E) Angle key and indicator

(F) Polar key and indicator

(G) Angle Select key and indicator

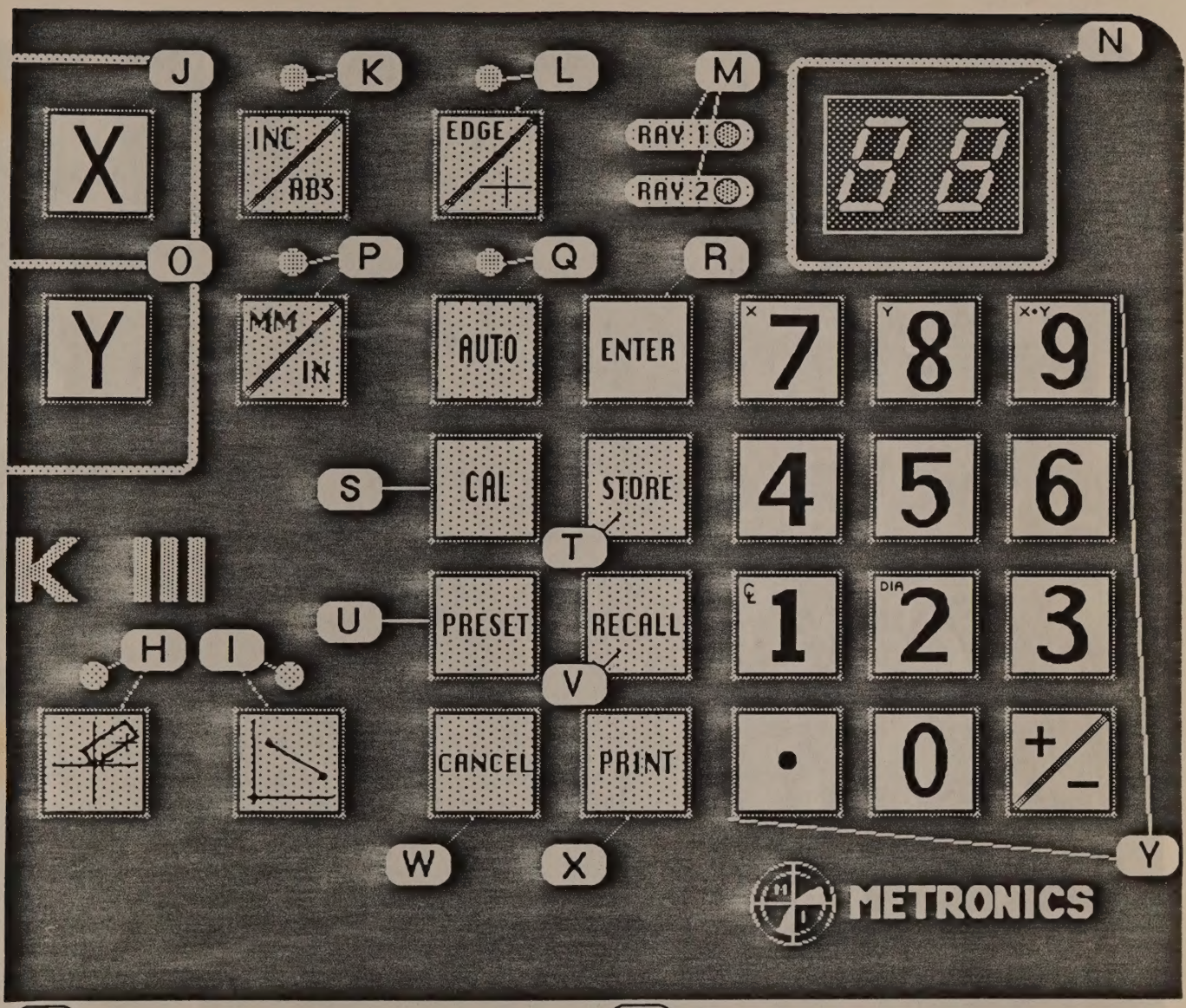
(H) Skew key and indicator

(I) Relative key and indicator

(J) X axis key

(K) Incremental / Absolute key and indicator

(L) Edge / Crosshair key and indicator



(M) Ray indicators

(N) Memory Display window

(O) Y axis key

(P) Metric / Inch key and indicator

(Q) Auto key and indicator

(R) Enter key

(S) Caliabrate key

(T) Memory Store key

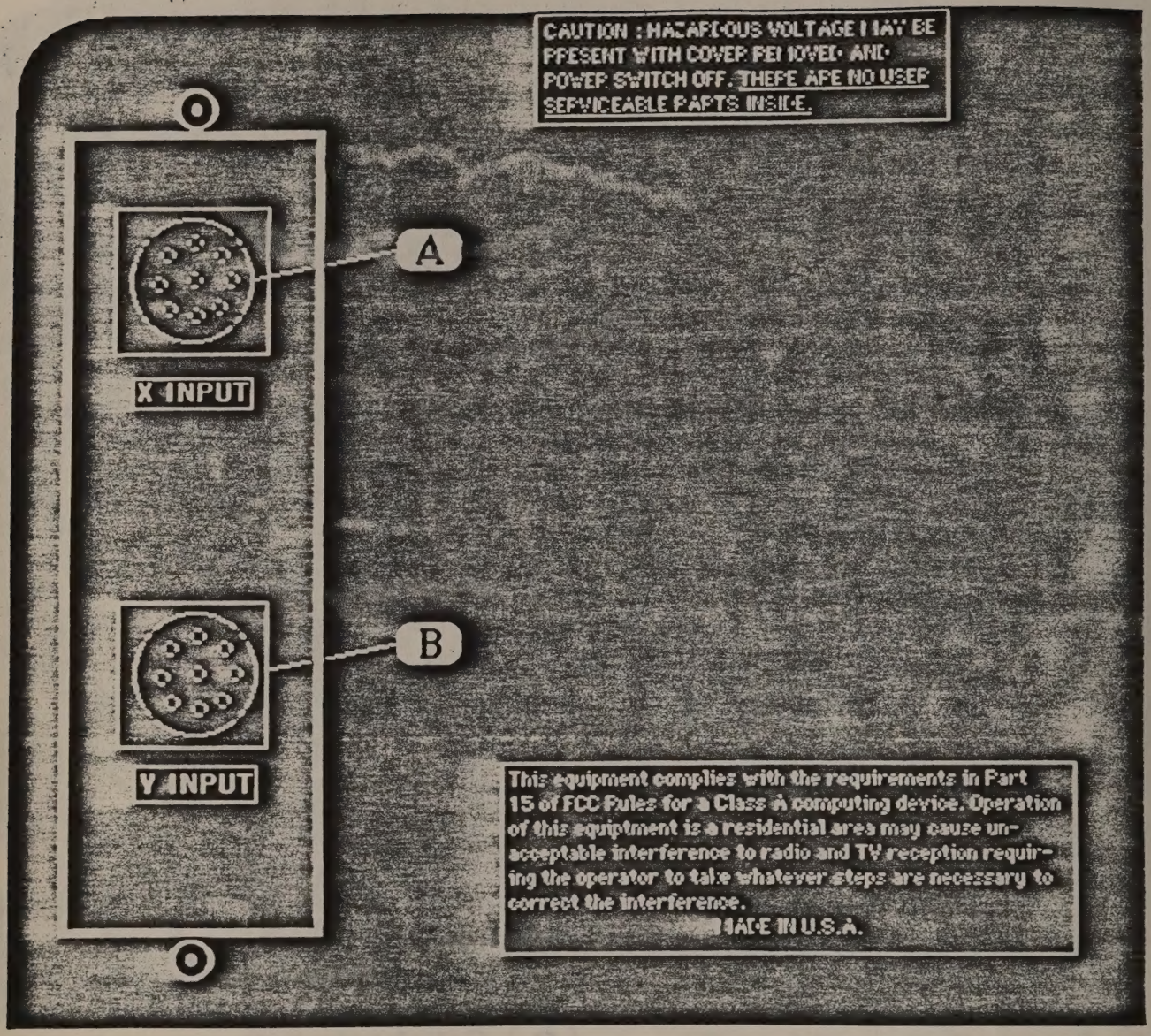
(U) Preset key

(V) Memory Recall key

(W) Cancel key

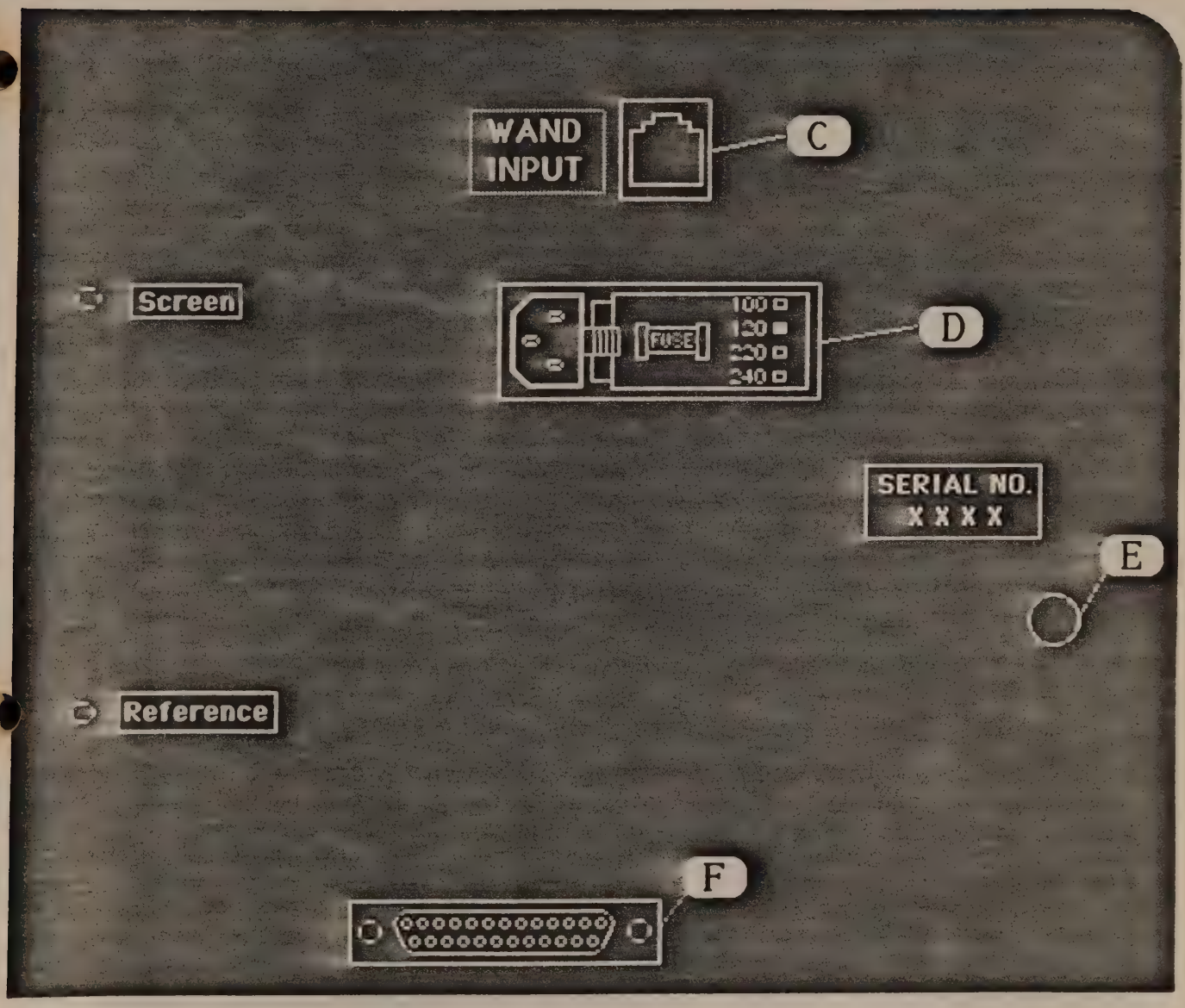
(X) Print key

(Y) Numeric keyboard


CAUTION : HAZARDOUS VOLTAGE MAY BE
PRESENT WITH COVER REMOVED AND
POWER SWITCH OFF. THERE ARE NO USER
SERVICEABLE PARTS INSIDE.
A
X INPUT
B
Y INPUT
This equipment complies with the requirements in Part
15 of FCC Rules for a Class A computing device. Operation
of this equipment in a residential area may cause un-
acceptable interference to radio and TV reception requir-
ing the operator to take whatever steps are necessary to
correct the interference.
MADE IN U.S.A.

(A) X axis input connector

(B) Y axis input connector



(C) Remote Keypad input

(D) Power input and Fuse holder

(E) Beeper hole

(F) Serial Port connector

Measuring With a QC-III

The QC-III is a digital readout that greatly simplifies the use of an optical comparator to perform precise, repeatable measurements. Not only will the QC-III compute straight line distances, but it can measure angles and radii as well.

The QC-III's Edge Detector senses changes in the brightness of a location on your comparator's screen, so the QC-III knows when you've crossed a shadow boundary. Edge detection is well-suited for making measurements where any point on a shadow boundary is as valid as any other on that boundary. Examples of this include points that lie on the circumference of a circle, and points that lie on a leg of an angle.

However, when you need to measure a particular point (instead of just any point that lies on a boundary), you will need to target that point with cross hairs.

With the QC-III, you are always measuring distances from a known datum point, known as the origin. It has coordinates 0, 0. The QC-III allows you to set that datum point to any physical point on the part you are inspecting.

Actually, there are two datum points -- the incremental datum and the absolute datum. This allows you to set an absolute 0, 0 point to measure all further points from, and also to set an incremental 0, 0 point from which you can make intermediate measurements.

To make your job easier, the QC-III will perform complex geometric and algebraic calculations at the touch of a few buttons. For example, you can calculate the position of a circle's center and find its radius by giving the QC-III a few points on the circle's circumference. Or, you can calculate what angle two legs of a part make with each other, again by giving the QC-III a few points.

But how do you "give" the QC-III the points to do these calculations? We call this process "targeting a point", and it can be done three ways. Continue reading to see exactly what the steps are to target a point.

The QC-III's Modes

The Quadra-Chek III has several different operating modes, all of which fall into one of three main groups, Targeting Modes, Display Modes and Configuration Modes.

Targeting Modes define how data points must be entered for the Quadra-Chek III to accept them. Display Modes define how that data is displayed. Configuration Modes tell the QC-III how to interpret the data it receives from your comparator.

These modes are described here in order to prepare you for the examples in the remainder of the manual. Please refer to these pages if "Mode Madness" starts to get to you.

Targeting Modes

Cross Hairs Mode

If the light above the EDGE/+ key is off, then the QC-III is in Cross Hairs Mode. In this mode, the QC-III's display is updated continuously, and the cross hairs are the targeting mechanism. To target and enter a point in this mode, place your cross hairs over the point to be entered and press ENTER.

Edge Mode

If the EDGE/+ light is on and the AUTO light is off, then the QC-III is in Edge Mode. In this mode, the QC-III's display is updated and a "beep" is generated after every edge crossing. An edge crossing occurs when the QC-III's light sensor crosses from a light area to a dark area, or from dark to light. This mode allows easy targeting of points that lie on shadow boundaries.

To target and enter a point along an edge, cross over the edge, and press ENTER. For best results, try to cross the edge perpendicularly. That is, cross the edge "straight on."

See the section "Edge Detector Calibration" for more details.

Auto Edge Mode

If the light above the AUTO key is on, then the QC-III is in Auto Edge Mode. This mode is almost identical to Edge Mode, except that every edge crossing will update the QC-III's displays and electronically press ENTER for you. In this mode, every edge crossing counts as an ENTER--this allows for very fast entry of points for many of the QC-III's functions.

In other words, to enter a point that lies on an edge, just cross over the edge. Again, remember to cross the edge perpendicularly.

Display Modes

MM/IN

When the light above the MM/IN button is on, all distances displayed are in millimeters. When the light is off, all distances are in inches.

Incremental/Absolute

When the light above the INC/ABS key is on, the distances displayed are being measured from the incremental datum (0, 0 point). When the light is off, distances are measured from the absolute datum.

Polar Mode

When the light above the POLAR button is on, the QC-III is in Polar Mode. All distance are measured from the current datum, and are displayed in the form (r, a). See "About Polar Measurement" in Advanced Concepts and Applications for a discussion of polar coordinates.

When this light is off, the QC-III is in Cartesian Mode, and all distances are displayed in the form (x, y) where 'x' is the horizontal distance from the current datum and 'y' is the vertical distance.

Note that the current datum is either the incremental datum or the absolute datum, depending upon the state of the INC/ABS light.

Configuration Modes

Calibration Mode

This is where you set up the edge detector so the QC-III can sense edge crossings. The QC-III will also calculate how far apart the edge detector is from the cross hairs so that you can switch between the three different targeting modes and still target points accurately.

Set Up Mode

Here you inform the QC-III about the comparator it is attached to. There are other settings that can be altered in Set Up Mode, and these are described in the section of the manual titled "Set Up Operation."

The QC-III In One Easy Lesson

This part of the manual will help you learn all of the QC-III's features. We've included a 2" X 2" slide on which is printed a "part." All the directions that follow refer to the slide. To use it, turn on your comparator and QC-III. The QC-III will display *tEStSFt* **x.x** (Software x.x Self-Test, where x.x is the version number). If any other message (such as *FAIL 1*) is now displayed, refer to "Error Messages" in Advanced Concepts and Applications, otherwise place the slide on your comparator so that it is oriented like the slide printed on page 18, and follow every step in order.

For all of the following examples it is important that the QC-III is set up for the correct count orientation. It is assumed for all demonstrations that if you move your cross hairs to the right (the image moves left) the count increases from *1* to *2* to *3*, not from *-1* to *-2* to *-3*. The same holds true for the Y axis. If you move the cross hairs up (image down), the count increases from *1* to *2* to *3*, not from *-1* to *-2* to *-3*.

To test this, make sure that the slide's projection on your comparator's screen has the same left-right and up-down orientation as the slide printed on page 18.

Make sure that you are in Cross Hairs Mode -- if the light above the EDGE/+ key is on, press that key once. Move the cross hairs to the right (if you were positioned on the left-hand edge of the slide, move toward the right-hand side) and the number in the X display should increase. If it does not, note that the X axis count direction needs reversing and we will correct it after we test the Y axis.

To test the Y axis move the cross hairs toward the top of the slide. The number in the Y display should increase. If it does not, note that the Y axis count direction needs reversing. If you found that neither axis needs reversing then skip the next section and continue on to Axis Zero Reset.

Reversing the Count Direction of an Axis

If you found that one or both axes are reading backwards, do the following:

1. Press the "5" key on the QC-III. The Y display shows *SEtUP*.
2. Press ENTER to verify User Set Up Mode.
3. Press the "5" key until the axis that needs reversing (X or Y) is displayed. *H dIr* (X direction) and *y dIr* (Y direction) are the choices.
4. Press ENTER. The QC-III displays *yES* (Yes) to confirm the change, and the axis direction is now reversed. The QC-III now returns to normal operating mode.
5. If you need to reverse both axes you need to do steps 1-4 for each axis.

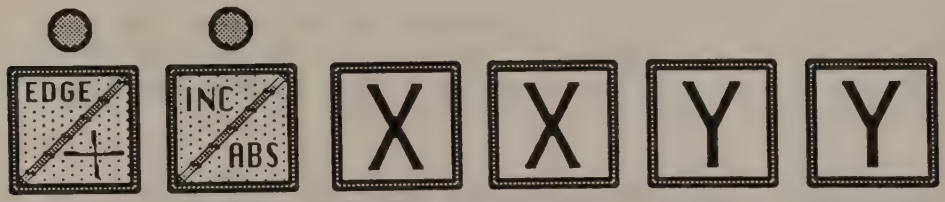
Repeat the count direction test and you will see that you are reading correctly.

Axis Zero Reset

The QC-III lets you select the origin points for both incremental and absolute measurements. What is the difference between absolute and incremental? Absolute measurement is the distance between a fixed starting point (the origin or 0, 0) on your comparator and another point to which you might move. Incremental measurement refers to distances that are not measured with reference to a fixed origin--instead, the distance is measured between the previous point and some new point. For example, if we move the cross hairs 5 inches in the positive X direction (to the right) from the 0, 0 origin, the absolute measurement is five -- and so is the incremental. Now, suppose we zero the incremental datum and we move in the same direction another 5 inches: incrementally we have moved another 5 inches, but the absolute distance (from origin to where we are now) is 10, not 5 (5+5=10).

The QC-III has two datum points, absolute and incremental, and both operate simultaneously. For this example, both must be zeroed before you begin. You should zero the absolute datum before you zero the incremental datum.

To zero the *absolute* datum, first make sure that you are in Cross Hairs Mode. Then center the cross hairs of your comparator over the point you want to be the origin (the unmoving point from which all further distances will be measured). Then press:



a. If the EDGE/+ light is on, press that key to turn it off.

b. Press the INC/ABS key so that the indicator light goes out.

c. Quickly press the X key twice. The X axis display will immediately turn to zeros.

d. Quickly press the Y key twice. The Y axis display will go to zeros.

If the INC/ABS light is now on, then you didn't perform the double keypress in either step c or d quickly enough. Repeat steps b, c, and d, making sure to press the X axis key twice *quickly* in step c, and the Y axis key twice *quickly* in step d.

Axis Zero Reset (Continued)

Next, zero the *incremental* datum. Follow these steps:

a. b.

a. Press the X key once. After a short pause, the X axis display will read zeros.

b. Press the Y key once. The Y axis display will go to zeros. Notice that you are now in Incremental Mode.

These steps established the current position as absolute 0, 0 and also as the point from which further incremental distances will be measured.

Notice that zeroing the absolute datum requires that you enter Absolute Mode and quickly press the axis key (X or Y) twice in a row. This is to prevent you from losing your absolute 0, 0 if you accidentally press the X or Y key while in Absolute Mode. Also, remember that the double keypress must be done *quickly* (within about 1/2 a second), or the QC-III will zero the incremental datum twice.

Zeroing the incremental datum requires only that you press the appropriate axis key (X or Y) once. Also, note that you end up in Incremental Mode after zeroing that datum.

Note on zeroing an axis in Edge Mode or Auto Edge Mode:

When in Edge Mode, first cross the edge you wish to zero on, and then press the key (X or Y) which corresponds to that axis. In other words, zeroing an axis in Edge Mode makes the last axis you crossed the new zero.

When in Auto Edge Mode, pressing X or Y will fill the corresponding display with dashes. The next edge you cross will set the selected axis to 0.

So, in Edge Mode, you cross the edge and then press X or Y. In Auto Edge Mode, you press X or Y and then cross the edge. Practice doing this in all three targeting modes, and try zeroing one axis (X or Y) along an edge (vertical or horizontal, respectively). Believe me, this will make more sense after you've done it a few times.

Edge Detector Calibration

The QC-III has a special light sensing capability so that when the sensor on your comparator's screen crosses from light to dark, or dark to light, the QC-III recognizes that you just crossed a shadow's edge. As you will see, Edge Detection will greatly increase your productivity, for you are no longer required to target each and every point with cross hairs.

Before we start measuring on the QC-III Quickie Slide, we must calibrate the QC-III so that it can correctly read the light sensors connected to your comparator. One of these sensors is connected to the comparator's screen, and is called the screen sensor. The other sensor is pointed directly at the comparator's light source, and is called the reference sensor.

These calibration steps should be done at least once per day, usually before the day's first part is inspected. Also, you should recalibrate if you change magnification, or start inspecting a part that causes the contrast between light and dark on the comparator's screen to change.

Just follow these steps to calibrate your Edge Detector:

a. b. c.

a. Press the CAL key until AutocAL (Auto Calibration) is displayed. Press ENTER to start the calibration process.

b. dArk (dark) appears. Move the comparator's stage so that the screen sensor is positioned over a dark section of the screen. Press ENTER.

c. LIGhE (light) is now displayed. Move the comparator's stage so the screen sensor is directly over a completely lit section of the screen, and press ENTER.

Now the QC-III can tell the difference between dark and light on the comparator's screen, and can therefore sense when an edge crossing takes place.

If you wish to further fine tune your Edge Detector, refer to "Dist Cal" in Advanced Concepts and Applications.

What About My Cross Hairs?

The QC-III allows you to switch back and forth between using either the cross hairs or the edge detector. But in order to do this, the QC-III must know how far apart the edge detector's screen sensor and the cross hairs are. *This calibration must be done every time you move the edge detector's screen sensor or change magnification.*

For this section, you can use any standard that has a vertical and horizontal edge. The standard that you use must be aligned by hand with your machine's travel. We apologize for any inconvenience this may cause.

Also, if you do not need to switch between Cross Hairs Mode and either Edge Mode or Auto Edge Mode, then you do not need to complete these steps. Continue on to the next section (Multi-Point Skew) instead.

a. Press the CAL key until *crosCAL* (Cross Hair Calibration) is displayed. Press ENTER.

b. Now that *H EdGE* (X edge) is displayed, find a *vertical* edge on the screen and, moving only the X axis of the stage, move the screen sensor over that edge. Press ENTER.

c. *H rEt* (X reticle) is now displayed. Moving only the X axis again, place the cross hairs on the same edge that you just crossed, and press ENTER.

d. *Y EdGE* (Y edge) is now displayed, prompting you to cross a *horizontal* edge with the screen sensor by moving only the Y axis. Do so and press ENTER.

e. *Y rEt* (Y reticle): Moving only the Y axis, place the cross hairs on the edge you just crossed, and press ENTER.

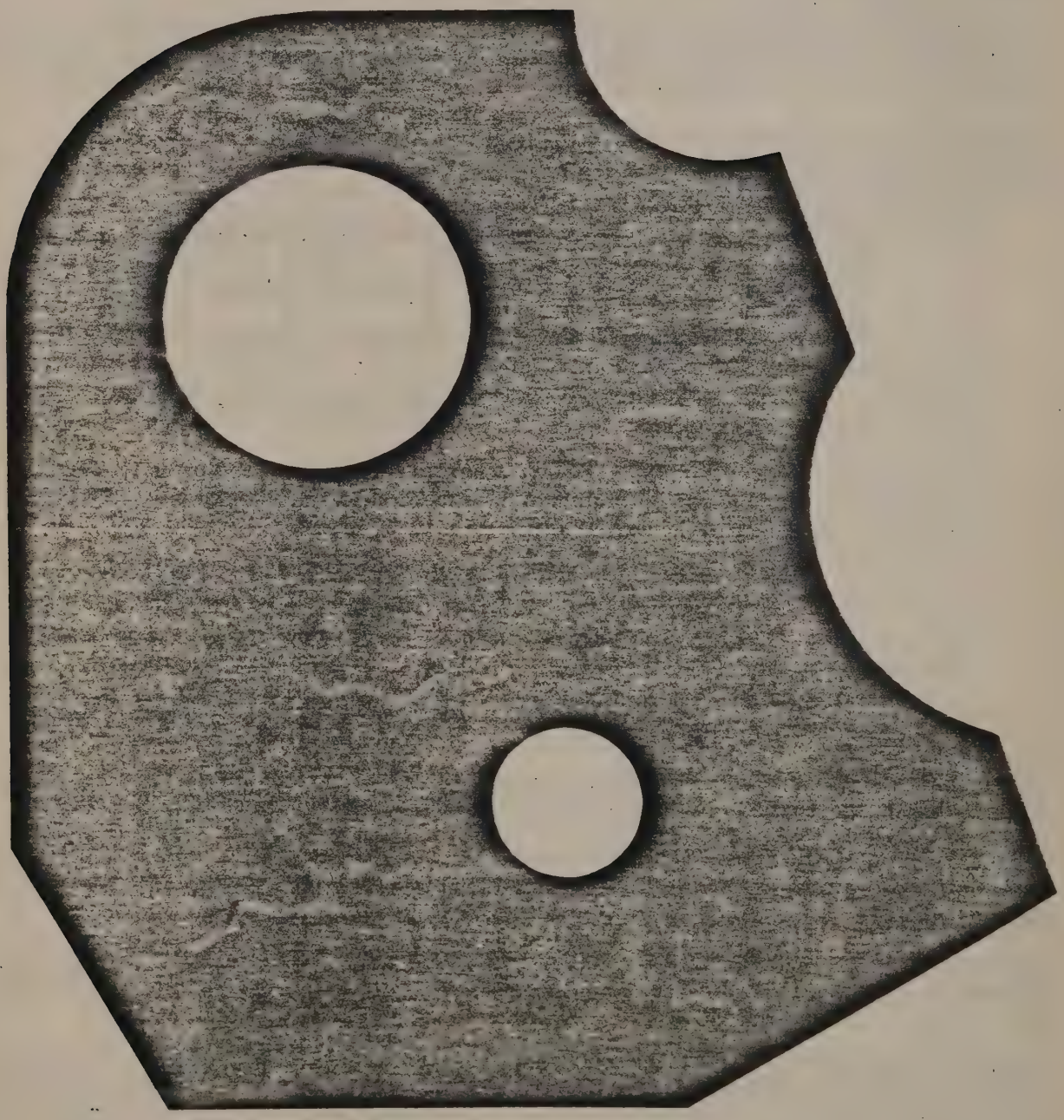
You can now switch between different targeting modes (Cross Hairs, Edge, and Auto Edge), even in the middle of any Multi-Point calculation and still obtain accurate results.

Be sure that you performed the above steps carefully, as any inaccuracy in those measurements will affect the accuracy of all further measurements when switching between targeting modes.

As you followed the above instructions, you may have noticed that there are three messages that appear that we did not deal with: *dISEcAL*, *PrE cAL* and *EdItcAL*. These are described in Advanced Concepts and Applications.

We will now start the QC-III Quickie Slide demonstration in earnest. All the examples given are done in Auto Edge Mode, with the exception of section D, Polar Mode. For your convenience, section B (Multi-Point Radius) is repeated after the QC-III Quickie Slide demonstration in Cross Hairs Mode and in Edge Mode in order to highlight the differences between the three Targeting Modes.

The Quickie Slide

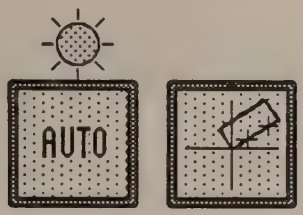


A. Multi-Point Skew

Accurate measurement of any part assumes that you have the part perfectly aligned on your optical comparator's screen. For almost every application, a misaligned part means inaccurate measurement, so your first step should always be to align the part.

When a part is misaligned -- or "skewed" -- you have a choice. You can either try moving it into perfect alignment by using the cross hairs, or you can let your QC-III do the work for you. With practice, you'll find that letting the QC-III do the job is both easier and more accurate.

The QC-III allows you to enter up to 9 points for this function. The more points you enter, and the farther apart they are from one another, the more precise your results will be. For this example, we will enter 5 points while in Auto Edge Mode.



a. b.

a. If you are not in Auto Edge Mode, press the AUTO key. Now, find a long horizontal or vertical edge on the slide to skew on. We recommend the horizontal side located at the bottom of the slide.

b. Press the SKEW key. The memory display window will read *P2* indicating that you must target and enter two points. Since we wish to use five points, repeatedly press the SKEW key to count up from *P2* to *P5*.

c. Cross the selected edge 5 times, keeping the points as far from each other as is reasonably possible. After the fifth crossing, the QC-III's incremental and absolute datum points will be set to *0*, *0*. You can use the CANCEL key if an invalid point accidentally gets entered during this process -- see "Cancel" in Advanced Concepts and Applications to learn what the CANCEL key can do for you.

The part is now electronically rotated to account for the part's "skewness." Even if the slide (or in real life, the edge of your part) is not perfectly parallel with the axes of your comparator, the QC-III will make automatic compensations for the part's skewness.

If your part is badly misaligned with respect to the travel of your machine, you will notice as you move along one axis (turn only one knob) both displays change when updated. This is because the QC-III knows you are really moving on a diagonal line with respect to the part.

When aligning with the Skew function the part must be placed within 45 degrees of the correct orientation -- otherwise, the orientation of the X and Y axes will change. And remember to always choose points as far apart as possible ensure the greatest accuracy.

Now that we've electronically aligned the part, we'll find the radius and center of a circle.

B. Multi-Point Radius

Multi-Point Radius (MPR) allows the operator of a Metronics QC-III to make very precise calculations about any given circle, or arc of circle. If you need to know the radius of a circular object, or where the exact center of a circle is, then MPR is the function for you.

To provide you with this information, the QC-III needs the coordinates of at least 3 points that lie on the circumference of the circle or arc. But in the real world, three points are indeed the bare essentials. Operator carelessness and quantization error can combine to distort the dimensions of even a geometrically perfect circle. When using only three data points, a slight mismeasurement of just one point seriously alters the measurement of the circle as a whole.

In order to combat these adversities, the Metronics QC-III can use up to 9 different points on the circle to eliminate much of the error that is inherent in any three point calculation.

When you have completed the steps below, the coordinates for the center of the circle will be stored as the incremental datum. To abort the MPR function once it is started, press CANCEL until the light above the RADIUS key goes out.

a. b. e. f.

For this example, we will use 9 points to define our circle, and we will enter the points while in Auto Edge Mode. Also, the farther apart the points are from each other, the more precise the results will be.

a. Make sure that you are in Auto Edge Mode. If you aren't, press the AUTO key once.

b. Press the RADIUS button until *P 9* is displayed in the memory display window. The *P 9* indicates that you should enter 9 different points along the circumference of the circle or arc whose radius you want to know. There are two circles and two arcs on the slide to choose from.

c. Cross over the circumference of the circle or arc 9 times, with the crossings being as far apart from each other as is conveniently possible. With each crossing, the number in the memory display window will count down by 1. You can use the CANCEL key if an invalid point is accidentally entered -- see "Cancel" in Advanced Concepts and Applications to learn exactly what the CANCEL key can do.

d. After you enter the final point (*P 1*), *r Rd 1 u 5* (radius) will appear in the Y axis window. After a short pause, the radius of the circle that best fits the points entered appears in the X display. The QC-III is temporarily placed in Polar Mode.

e. If your QC-III has an optional printer attached and you wish to print out the radius, press the PRINT key.

f. If you wish to see the circle's diameter displayed, press "2" on the QC-III's faceplate. The diameter appears in the X axis window, and *d 1 R* appears in the Y. If you wish to print out the diameter, press PRINT now.

g. Any key pressed now will return the QC-III to normal operation, and that key will be acted upon accordingly. For example, pressing the RADIUS button would put the QC-III back into its normal operational mode, and initiate another Multi-Point Radius calculation in one step. For this example, press ENTER to return to the normal operational mode.

Fine Points About MPR

After completing step d listed above the circle's center point will automatically be stored as the incremental datum. As soon as you complete step g, you are now measuring from the circle's center to the last point entered (*P 1*). Note that the distance from *P 1* to the circle's center is not necessarily the same as the best-fit radius. This is to be expected, as *P 1* was only one of 9 points used to calculate the circle's radius. That's why the displayed distance may have changed if you pressed POLAR in step g.

Because the center of the circle has been stored as the incremental datum, you can transfer this point to the datum memory. See "Memory Operation" in Advanced Concepts and Applications to learn about the memory function.

Also, the Relative function allows you to see where the center of the circle falls in relation to the absolute datum. See "More About Relative" in Advanced Concepts and Applications.

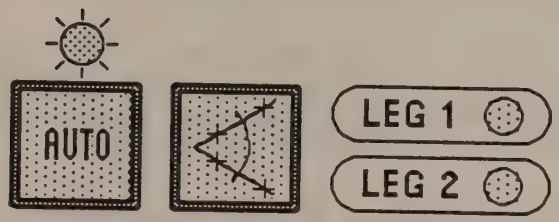
Also, the diameter function referred to in step f works by doubling the distance displayed in Polar Mode. The diameter function will work whenever you are in Polar Mode, but may not have significance. If, for example, you are not measuring radii but are making some other polar measurement, pressing the diameter key will work but the result may not make sense.

Now we're ready for the next section, Multi-Point Angle.

C. Multi-Point Angle

Using your QC-III, you can easily measure an angle and then perform subsequent measurements involving the angle just found. To measure an angle, like the one on the QC-III Quickie Slide, first be sure that the polar light is *off*. If it's on, press the POLAR button once.

The QC-III lets you select the number of points you wish to use to define each leg of the angle. As you may know, you need at least 2 points per leg to define an angle, but Multi-Point Angle (MPA) will accept up to 9 points per leg. These extra points allow results of greater precision than ever before. In the following section, we will use 4 points per leg, and enter them while in Auto Edge Mode. Choose any angle on the QC-III Quickie Slide to use in the following example. We recommend either angle made with the horizontal line at the bottom of the slide.



a. If you are not in Auto Edge Mode, press the AUTO key once.

b. Press the ANGLE button until *P 4* appears in the upper right display, telling you to target and enter 4 points along the path of each leg. The Leg 1 indicator is now lit, indicating that you have 4 points left to enter for the angle's first leg.

c. Cross over the first leg 4 times, making sure that each point entered is *closer* to the angle's vertex than the previous one. If you enter the points in a random fashion, erroneous results might be generated. Also, make sure that all crossings are as far away from each other as possible. Each crossing will decrease the number displayed in the memory display window by 1.

d. After entering the fourth point (*P 1*) for leg 1, the Leg 1 indicator will turn off and the Leg 2 indicator will turn on. *P 4* will again be displayed in the memory display window, prompting you to enter the 4 points for leg 2.

e. Cross over leg 2 four times, but with each point located *further* from the vertex than the previous one.

f. After the last point is entered, ANGLE will be displayed in the X axis window, and the best-fit angle will be displayed in the Y axis window. Also, the QC-III is automatically put into Polar Mode.

g. If you wish to print out of this best-fit angle, press PRINT.

At this point the ANGLE and POLAR indicator lights will both be on. The vertex of the included angle is automatically stored as the incremental datum, where it can immediately be used for additional calculations or stored in the datum memory for later use. See "Memory Operation" in Advanced Concepts and Applications for a description of datum memory.

Angle Select

Now that you have the best-fit angle displayed, you can display all the angles associated with it by pressing the ANGLE SELECT key repeatedly while the lights above the ANGLE and POLAR keys are both on.

If you perform these steps with the ANGLE light *off*, you are really using the QC-III's Polar Select Function which is described in Advanced Concepts and Applications.

To view the associated angles, follow these steps. The illustrations on the next page will help you visualize each angle.

1. Make sure that both the ANGLE and POLAR lights are *on*. (This should be the case from the previous demonstration.)

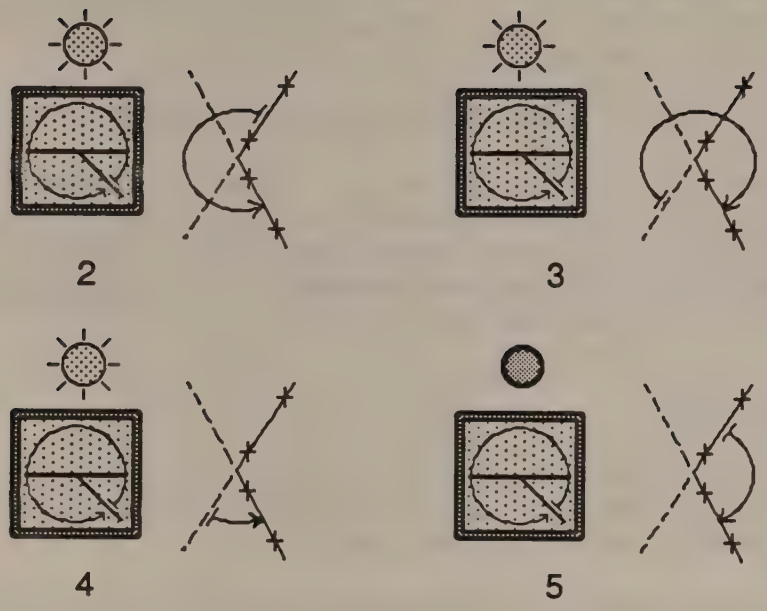
2. To calculate the full circle (360°) minus the included angle as in figure 2 on the next page, simply press the ANGLE SELECT key once and this measurement will appear in the Y display. The indicator light will go on showing that you are no longer displaying the included angle.

3. Now, press the ANGLE SELECT key again to calculate the included angle plus 180 degrees (figure 3).

4. If you press the button again, you'll see 180 degrees minus the original angle (figure 4).

5. And if you press the button a final time, you'll see the original angle itself once again displayed in the Y display. The indicator light will go out showing that you are displaying the included angle (figure 5).

6. Now, to tell the QC-III that you are done with the Angle Measurement Function, press ENTER. This keypress returns the QC-III to normal operating mode, with the QC-III in Cartesian Mode.



Fine Point About Multi-Point Angle

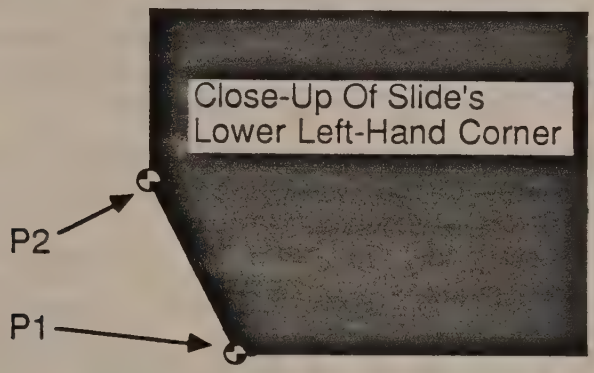
If you exited step 6 by pressing POLAR, you might have noticed that the displayed angle changed. There are two explanations for this. First, you are now seeing the angle between the Positive X axis and your current position, not the included angle.

Second, even if your first leg <u>was</u> the positive X axis, you are now seeing the angle between the X axis and the leg defined by the last point entered (*P 1*, leg 2) and the angle's vertex. The previously displayed best-fit angle was calculated from leg 1 and leg 2. These two angles will be equal only if point *P 1* of leg 2 falls exactly on leg 2. This is unlikely because a total of 4 points were used to define leg 2.

Now let's see how the QC-III's Polar Mode works.

D. Polar Mode

The QC-III's Polar Mode simultaneously computes the straight-line distance from one point to another, and the angle this line makes with the X axis. Refer to the lower right edge of the slide in this section. To see how it works, follow these steps:



a. Make sure that you are in Cross Hairs Mode. If you aren't, press the EDGE/+ key once. (This is the only section of the QC-III Quickie Slide demonstration done in Cross Hairs Mode.)

b. Press the POLAR button until the Polar light goes out. This will automatically exit the QC-III from any previous mode it was in.

c. Target P1 (the lower endpoint of the diagonal line near the part's lower left-hand corner). Zero the incremental datum (press X | Y).

d. Target the other endpoint of the line (P2). Press POLAR.

e. The X display will now show, in mm or inches, the straight line distance between points P1 and P2. The Y display will show the angle made by line P1--P2 and the positive X axis.

If you wish to see what angle line P1-P2 makes with some axis other than the positive X axis, refer to "Polar Select" in Advanced Concepts and Applications.

The reason why this section was done in Cross Hairs Mode is that it is impossible to target a specific point with the Edge Detector. With Edge Detection, the best you can do is target any point on an edge, not any *specific* point on an edge. For most applications (like Multi-Point Radius), all points on an edge are equally valid. For this section, we needed to measure from one specific point to another, so we did it in Cross Hairs Mode.

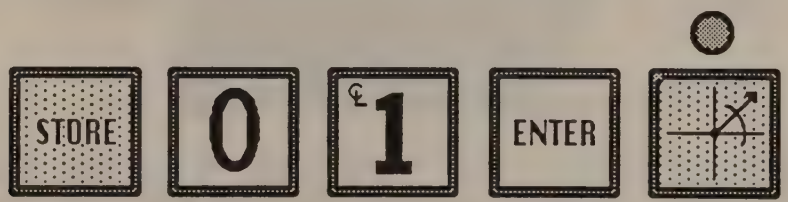
E. Relative Function

The QC-III's Relative Function allows you to do complex multi-dimension measurements quickly and easily. For example, you can measure the relative distance between the centers of two different circles.

However, to use the relative function, we must learn about the QC-III's datum memory.

Datum memory stores user-defined datum points. Up to 100 different datum points can be stored in this memory, with each point having different X/Y coordinates. These points can be recalled at any time and are protected from power failure. You can learn more about memory operation but at your leisure (see Advanced Concepts and Applications, "Memory Operation").

Refer now to the two circles connected by line E on the slide. Follow the steps below to measure the radii of both circles and then store their two centers.



2. 3. 3. 3. 4.

5. 5. 5. 5.

1. Find the radius of the smaller circle, the same way we did in part B above. Target points that are as far apart from each other as possible and enter them as in part B (Multi-Point Radius).

2. When the radius appears in the display, press the STORE key.

3. Then press the "0" key, followed by the "1" key. Then press ENTER. This will store the center as datum memory point *01*.

4. For convenience, you should press the POLAR key to exit Polar Mode if you're in Polar now. This will speed up the display.

5. Next, find the radius of the larger circle, the same way we did in part B. Press STORE, followed by "0", then "2", then ENTER. You've just stored the second center as point *02* in datum memory.

Now that you have stored the two points you can find the distance between them just as you would between any two datum points memory. To do this press the following keys in sequence:

The Relative light will now be on and the displays will show the distance between center 1 and center 2. If you want to see this distance in Polar or Cartesian displays, press the POLAR key to toggle between the two modes.

Note: The Relative Function is more powerful than shown in this one example. Refer to "More About Relative" in Advanced Concepts and Applications to learn what else the RELATIVE key can do.

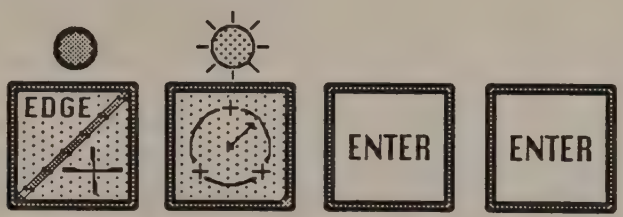
You now wish to exit relative mode, so press the RELATIVE key.

Multi-Point Radius In Different Targeting Modes

This section of the QC-III Quickie Slide demonstration will allow you to become more familiar with Cross Hairs Mode and Edge Mode. The actual differences in targeting points are highlighted in step c of each example below. The other steps all remain the same as in section B (Multi-Point Radius), except for the number of points used.

Remember, the farther apart the points are from each other, the more precise the results will be.

MPR in Cross Hairs Mode



a. Make sure that you are in Cross Hairs Mode (the light above the EDGE/+ key is off). If you aren't, press that key once.

b. Press the RADIUS button until *P5* is displayed in the memory display window.

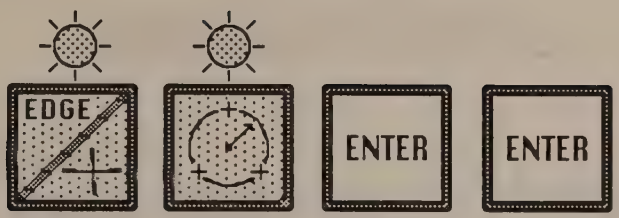
c. ***Place your cross hairs over any point on the circumference of the circle, and press ENTER.*** The number in the memory display window will count down by 1.

d. Repeat step c until all 5 points have been entered.

e. After you enter the final point (*P1*), *rAd1uS* will appear in the Y axis window. After a short pause, the radius of the circle that best fits the points entered appears in the X display. The QC-III is also automatically placed in Polar Mode.

f. Now, steps e-g listed in section B (Multi-Point Radius) can all be performed, if you wish. Otherwise, press ENTER key to return to normal operating procedure, and continue with the next example.

MPR in Edge Mode



a. Make sure that you are in Edge Mode (light above EDGE/+ key *on*, AUTO light *off*). If you aren't, press the EDGE/+ key until that light is lit.

b. Press the RADIUS button until *P5* is displayed in the memory display window.

c. ***Cross over any point on the circumference of the circle, and press ENTER.*** The number in the memory display window will count down by 1.

d. Repeat step c until all 5 points have been entered.

e. After you enter the final point (*P 1*), *rAd 1u5* will appear in the Y axis window. After a short pause, the radius of the circle that best fits the points entered appears in the X display. The QC-III is also automatically placed in Polar Mode.

f. Now, steps e-g listed in section B (Multi-Point Radius) can all be performed, if you wish. Otherwise, press ENTER to return to normal operating procedure.

This concludes the QC-III Quickie Slide demonstration. More information may be found in the following section, Advanced Concepts and Applications.

Advanced Concepts and Applications

Cancel 31
Preset Operation 32
More About Presets 33
More About Relative 34
More About Polar Measurement 35
Polar Select 36
Establishing a Datum at a Non-Square Corner 37
Memory Operation 38
A Time Saving Hint 39
Part programming 40
Skew On Two Radii 42
Checking for Parallel Lines 43
True Position Tolerance 44
Bolt Circle Calculation 44
Center Line 45
Dist Cal 46
Edit Cal and Print Cal 47
Remote Programmable Keypad 48
Error Messages 49

Cancel

The QC-III has several Multi-Point features that require more than one point to complete. For example, Multi-Point Radius (MPR) accepts up to 9 points, and calculates the radius and center of the circle that best fits those points.

Let's suppose that you are about to enter the last point of a 9 point MPR calculation while in Auto Edge Mode and you happen to cross a stray shadow on the view screen. The QC-III will accept that last point, and display the best fit radius as usual. But that last point was a mistake...

Don't panic! You can tell the QC-III to take one step back, and you can re-enter the last point. All you have to do is press the CANCEL key and (Presto!) *P 1* appears in the memory display window, prompting you for that last point again. Just target the point correctly, and the correct radius measurement will be displayed.

The CANCEL key works in all targeting modes, not just Auto Edge Mode, and will save you much time. In any Multi-Point function (MP Radius, MP Skew, MP Angle), CANCEL allows you to re-enter the point just entered, even if it was the last point needed to complete the function. Note that there is one exception: the very last point of a Multi-Point Skew operation cannot be recalled with the CANCEL key.

Now, suppose that you accidentally press the RADIUS button. To exit MPR and return to normal operating procedure, just press CANCEL. Or, suppose that you've entered 4 points of a 9 point MPR and decide that you don't want to do an MPR after all. Just press CANCEL until the light above the RADIUS key goes out, and you're back in normal operating procedure.

Also, CANCEL gives you a graceful way to exit to normal operating procedure if you accidentally press the CAL key or the "5" key.

Lastly, if you are presetting an axis and type a wrong number, pressing CANCEL will clear the display and let you preset the axis from scratch.

Remember that the CANCEL key serves many purposes. First, to back up one step at any time in any Multi-Point calculation. Second, to exit entirely from a Multi-Point function. Third, to exit gracefully if you press CAL or "5" by mistake. Lastly, to allow you to restart a preset if you type a wrong number.

Preset Operation

You may want to establish an incremental or absolute datum without actually targeting the datum point. If so, do this:

b. c. d. e. e. e. e.

To preset the X axis display:

a. If you are in Edge Mode, cross the edge that you wish to preset from. If you are in Cross Hairs Mode, place the cross hairs over the point you wish to preset from.

b. Press the PRESET key.

c. Press the X key.

d. If you wish to enter an absolute preset press the INC/ABS key so that the indicator light goes out.

e. Enter the number that you wish to preset (1.2 in the example above), and press ENTER. The X axis display now reads *1.2000*. The QC-III will now start measuring from this new number. For example, if you target a point 1.5 inches to the right of the previously targeted point, the X display will read *2.7000*.

b. c'. d. e. e. e. e.

To preset the Y axis display, follow all the steps listed above, *except press the Y axis key instead in the X axis key in step c.* The Y axis display now reads *1.2000*. The QC-III will now start measuring from this new number. If you target a point 0.3 inches above the previously targeted point, the Y display will read *1.5000*.

More About Presets

When you establish a new origin point in either INC or ABS you are in effect telling the QC-III that your new origin is the preset distance away from the location displayed when you press the PRESET key.

Let's clarify that with a few examples. You are inspecting a frammet that is a piece of a larger assembly and your dimensions for this part are from the composite drawing. Your absolute origin in this case is 3 inches off the left edge of your frammet. In order to have the displays read the same as the dimensions on your drawing you need to preset your absolute datum to compensate. For the purpose of our example we will only talk about the X axis. To do this, first make sure you are in Cross Hair Mode (EDGE/+ light off). Now position your cross hairs over the left edge of the part and press the following keys in order:

You will now see *3.0000* inches displayed in the X axis which is the dimension that is shown on our frammet assembly print. Now, as you measure the part you will have the correct offset added to your measurements.

For our next example we are inspecting a widget with a feature that is X *1.2500* inches and Y *1.5600* inches away from the lower left corner. When we measure this feature we would like to display the deviation from this dimension instead of the actual dimension. Suppose the feature on our widget is actually at *1.2552*, *1.5623* not where it is supposed to be at *1.2500*, *1.5600*. When we measure we want to see *0.0052*, *0.0023*. Make sure you are in Cross Hairs Mode (EDGE/+ light off), and position your cross hairs over the lower left corner. Press the following keys in order:

The displays will now show *-1.2500*, *-1.5600* and when you move to the feature, they will display the deviation from the specified dimension.

More About Relative

The Relative function works by showing you the distance between the memory datum shown in the memory window, and either the incremental datum or the absolute datum depending upon the state of the INC/ABS light. In the example given in Section One we recalled datum *01* (loading it into the incremental datum) and then we pressed RELATIVE | 02 | ENTER.

You can save some button pushing when you want just the center to center distance by only storing the first hole and when you are through with the second hole press RELATIVE, ENTER. This works because the second hole's center is the incremental datum as a result of the radius function and the memory window is still showing the datum number of your first hole.

The distance from any memory datum to the absolute datum can also be found by pressing RELATIVE | TWO MEMORY DIGITS | ENTER and enter into absolute mode (INC/ABS light off). Remember that TWO MEMORY DIGITS can fall anywhere between *00* and *99*.

To see the distance between the incremental datum and the absolute datum at any time, just press the RELATIVE key once. The RELATIVE and INC/ABS lights will blink to remind you of what is being displayed. Pressing RELATIVE again will return the QC-III to normal operating procedure.

For example, if you press RELATIVE and *1.0000, 2.0000* is displayed, your incremental datum is 1 inch to the right and 2 inches above your absolute datum. If you wish to see the straight line distance between the two datums, press the POLAR key.

This function is especially useful for finding the distance from the absolute datum to a circle's center or an angle's vertex, as those centers and vertices are automatically stored in the incremental datum after their respective functions (Multi-Point Radius, Multi-Point Angle) are completed.

More About Polar Measurement

Don't let polar measurement confuse you. The POLAR key merely changes the way the information is shown -- but it's the same information, just like inches and millimeters are two different ways of expressing the same distance. In Cartesian measurements the distance is expressed with a pair of coordinates X and Y. This is the system we are most familiar with. In a polar coordinate system we also express a distance with a pair of coordinates r and a. These are the radial distance and the angle coordinates.

Surveyors use polar coordinates all the time. When land is surveyed the plot is not defined by Latitude and Longitude for all the corners of the property (Latitude and Longitude being a somewhat modified version of Cartesian measurement). Rather, it is defined by polar measurement. The survey will read "from boundary marker R236 (the origin 0, 0) northeast 36° 52' for a distance of 653.21 feet," etc., etc. This is polar measurement (from some origin you travel some distance in some direction). The surveyor used north as 0°, but north is not really a standard direction when it comes to comparators so we use the positive X axis as our 0° line.

The surveyor also reads his angles in the clockwise direction (his angles go up as he swings through north east to east). Scientific convention dictates that we use the counter clockwise direction to measure angles. So if you swing from the positive X axis around to the positive Y axis and on around to the negative X axis the polar angle will increase. We are not locked in to this standard, as you can change the angle reading direction and the 0° axis with the Polar Select function.

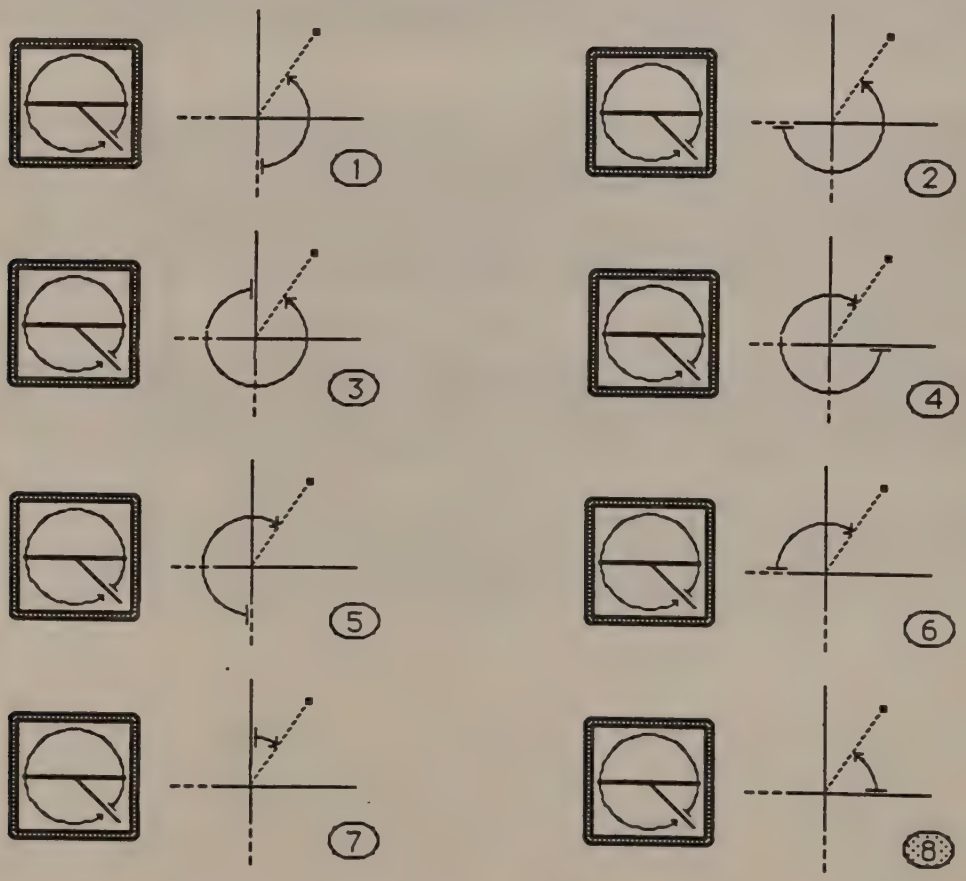
Polar measurements can be very useful for things like straight line measurements (two points not aligned with the X or Y axes of the part and the dimension is the straight line between them) and quick angle measurements.

Polar Select

Reread section D, Polar Mode, and repeat the steps found there before continuing with this section.

Now that you've measured the polar angle (the one in your X display right now), you can automatically read all the angles associated with other axes. What if we're interested in the angle line P1--P2 makes with the Y axis or some other line? The Polar Select function gives you the angle you want at the touch of a button.

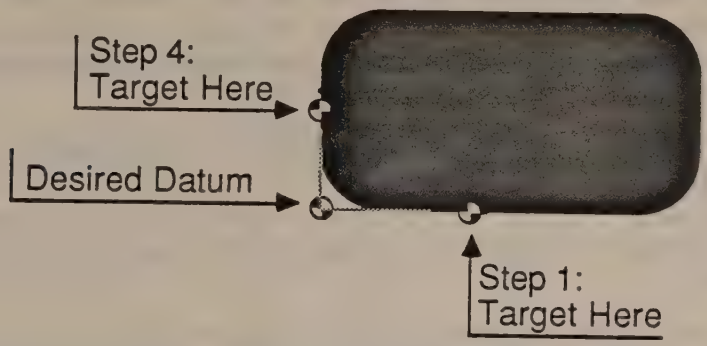
When you press the ANGLE SELECT button, the Y display will show the new angle made by the negative Y axis in the counterclockwise direction (fig. 1). As you continue, the angle displayed will change as shown in figure 2-8. Note: The angle select light will now be on, indicating that the angle is not measured counter clockwise from the positive X axis.



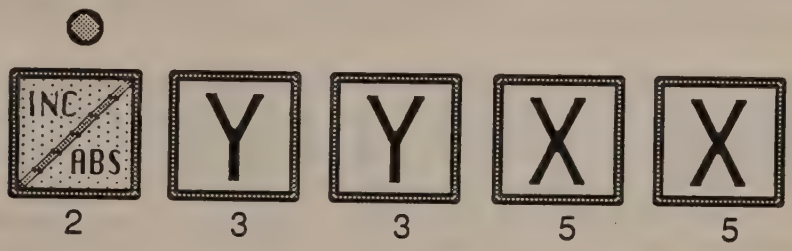
When you press ANGLE SELECT the last time (fig. 8), you will see the original angle in the Y display and the indicator light will go out.

Establishing a Datum at a Non-Square Corner

To establish an incremental or absolute datum, you would normally enter Cross Hairs Mode, target the desired datum point and press X | Y (for an incremental datum) or INC/ABS | X | X | Y | Y (for an absolute datum).



What if, as in our slide (and in our illustration), there is no perpendicular corner to establish a datum at? You enter Cross Hairs Mode or Edge Mode (not Auto Edge Mode), and then zero each axis separately as follows:



1. If you are in Cross Hairs Mode, target any point on the X axis of the part (the lower horizontal edge). If you are in Edge Mode, cross over any point on the edge containing the X axis of the part.
2. Press the INC/ABS button to turn the light off.
3. Press the Y button twice *quickly* to zero.
4. Now target any point on the Y axis (the vertical edge) as described in step 1.
5. Press X twice *quickly* to zero.

If the INC/ABS light is now on, then you didn't perform the double keypress in step 3 or 5 quickly enough. Repeat steps 2-5, making sure to press the X axis key twice *quickly* in step 3, and the Y axis key twice *quickly* in step 5.

These steps work for Cross Hairs Mode and for Edge Mode. They will not work in Auto Edge Mode -- use the Edge Mode instead.

You have now established the 0, 0 absolute datum point.

Memory Operation

The memories in the QC-III are not quite the same as you might expect on a pocket calculator. They are position memories, not just numeric memories. As an example, if the displays read [X 1.0000 Y 1.0000] and you store these numbers, when you recall this same datum memory you will only see these same numbers if you are in exactly the same position as when you stored them. ***What you see displayed when you recall a datum memory is the distance from the memory point to your current position.***

To explain this more fully, the memory feature is often used to program the inspection of a part. To do this you enter the *negative* values of the coordinates of the features of the part you wish to inspect (from the blue print). You can then inspect the part, targeting the feature and recalling the corresponding datum memory.

Now the display will show the distance to the datum memory point (deviation). This will automatically add the true measurement to the specified dimension and you can now see if the part is within tolerance at a glance. For example, if you had programmed memory 01 with [X -1.0000 Y -2.0000] and the actual measurement was [X 0.9982 Y 2.0012] after you recall memory 01 you would see [X -0.0018 Y 0.0012].

We can see that if we were directly positioned over the specified dimension we would see [X 0.0000 Y 0.0000]. As you can see, ***the memory can be thought of as a collection of alternate incremental datum points*** (0, 0 points). This is a very important concept as all memory operations are based on this principle. When we programmed the datum memory in the previous example, we specified a new datum point to be at [X 1.0000 Y 2.0000].

Note: Read the section "Part Programming" before you actually try this, as there are a few more considerations before you proceed.

All datum memories are "tied" to the current absolute datum. If you shift your absolute datum 1 inch to the left, all of your datum memories will appear to move 1 inch to the left also. Actually, they are still the same distance away from your absolute datum, it's just the absolute datum that's moved.

The other use for datum memory in the QC-III is "scratchpad" memory. We saw an example in the Relative section above: we used the datum memory to temporarily store the location of hole centers so we could find the distance between them at a later time. You may have noticed that all that was required to store the center of a circle (after completing the radius function) was to press STORE, two digits, and ENTER. To store a point directly under the cross hairs, a different technique is needed. When you want to store such a point you must first zero the display (incremental) and then store the point.

The reason for this different technique is because the memory stores datum points or 0, 0 points. If you are directly over the point you wish to store, you want to make that point a reference point or a point that you can measure from so you assign a 0, 0 value to that point. You don't have to zero the display to store a center of a circle (or a vertex from the angle function) because the QC-III does that for you.

To summarize datum memory operation:

1. Store a point directly under the cross hairs	Zero INC first then Storage Sequence
2. Store a center or vertex after using the radius or angle functions	Use Storage Sequence
3. Preprogram a series of features	Zero ABS then preset coordinates then Storage Sequence

The following are valid Storage Sequences:

Stores data in the datum memory location specified by the two digits.

Stores data in the datum memory location shown in the memory window.

Stores data in the next datum memory location.

A Time Saving Hint

If you're storing several datum points in a row in the datum memory and you want to store them as *01*, *02*, *03*, etc., just press STORE twice in a row (STORE-STORE) for the second and subsequent points. The QC-III will automatically number them *02*, *03*, etc.

Part programming

When you are programming a part for inspection there are a few things you must consider. One is the direction you are traveling on the part. Blueprints are usually dimensioned positively, but when you put your part on the comparator positive and negative may be switched. The best way to determine this is to try your part on your machine and see.

Put your part on your machine and measure a feature on your part from the reference datum on your print. If your dimension is positive then you would preset the dimensions with a minus sign. (Similarly, if the dimension is negative, you would use a positive preset.) The reason for this is that as you measure out to your feature (in the positive direction) you want to end up at *0.0000*, *0.0000*.

In order to achieve this you need to enter a negative number to start out the process and "count down" to the feature *0*, *0*. If however you found that as you move from your zero point to your feature the displays are negative you can preset positive numbers. After determining how to handle the sign of your measurements you can start programming your piece.

a. Make sure that the INC/ABS light is off (Absolute Mode). If not, press that key once.

b. First zero X and Y absolute by pressing X | X | Y | Y. Remember the datum memory is a position memory and you must define these dimensions as distances from some absolute origin. It is also important that the stage not be moved while programming or the features will be mislocated by the amount of the movement.

c. Now preset the first dimension in the X and Y displays (incremental preset). For example, if the blueprint reads 1.5, 2.2 for a feature, you would preset *-1.5000*, *-2.2000*. Refer to the sections "Preset Operation" and "More About Presets" for the steps needed to preset a datum.

d. Press STORE | 0 | 1 | ENTER. You have now stored the first point of your inspection sequence. To continue with this procedure repeat step c and then, instead of pressing STORE | 0 | 2 | ENTER, just press STORE | STORE. The dimensions will be stored in the next datum memory position -- *02*, *03*, etc.

Now that you have programmed your inspection sequence you can inspect your part. Follow these steps:

1. Place your part on the stage and skew align if necessary.
2. Zero absolute at the 0, 0 point on the part.
3. Press RECALL | 0 | 1 | ENTER.
4. Move to your first feature and you will see the deviation displayed. To continue this process just press RECALL | RECALL and move to your next point. When you are through with this piece you can start over at step 1 with your next piece.

If one of your features is the center of a circle, then compute the center using Multi-Point Radius. Then press RELATIVE | TWO MEMORY DIGITS | ENTER to display the deviation of the measured center from the point stored in the memory partition named by TWO MEMORY DIGITS.

A similar procedure is used if your feature is the vertex of an angle. Calculate the vertex using Multi-Point Angle, then press RELATIVE | TWO MEMORY DIGITS | ENTER to display the deviation of the measured vertex from the point stored in the memory partition named by TWO MEMORY DIGITS.

Skew On Two Radii

The RECALL function, in addition to its uses as described in the section "Memory Operation," allows you to use stored datums as data points for any Multi-Point function.

Suppose you need to skew align a part that has no vertical or horizontal sides, but instead has two circles whose centers define a vertical or horizontal datum line. To skew on those two points, you need to follow these steps:

a. Place the part on the stage with the two alignment holes approximately aligned with the axis they represent. For example, if the X axis runs through the holes then place the part with the two holes nearly horizontal.

b. Do a radius calculation on one of the holes. Then store the center in a datum memory position. For this example, we'll use memory location *04*, so press STORE | 04 | ENTER.

c. Do a radius calculation on the other hole, and store it in location *05*.

d. Press the SKEW button once to initiate a 2 point skew operation.

e. Press RECALL | 04 | ENTER. Notice that the *P2* in the memory display window counted down to *P1*, indicating that memory point 04 was accepted as the first point for the skew function.

f. Press RECALL | 05 | ENTER. You have now aligned your part with the reference axis traveling through the centers of the two holes, and memory point 05 has become your new absolute datum.

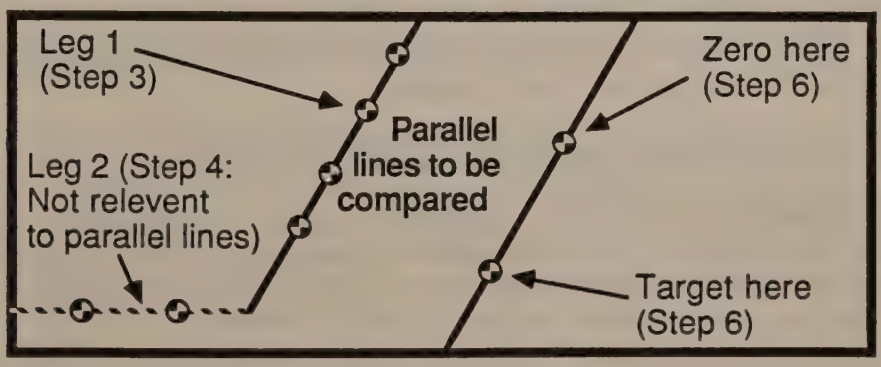
Note: Since there is a new absolute datum, all the datum memory points have also been "moved." Memories *04* and *05* no longer represent the centers of the two holes. They were only used as data for the skew function and lost all relevance to the part after skewing. See "Memory Operation" in this section for more details.

Checking for Parallel Lines

The QC-III can be used to determine how close two lines are to being parallel. To do this you must first establish a "base line" -- namely, the line you wish to compare other lines to. This is done using the ANGLE function. The first leg of the angle you measure is your base line.

For this example, we will use 4 points to establish the base line while in Auto Edge Mode.

1. If you are not in Auto Edge Mode, press the AUTO key.
2. Press the ANGLE key twice, so that *P 4* appears in the memory window.
3. Measure Leg 1 (the base line) as described in part C of Section One.
4. For Leg 2, target any 4 different points that are not on the same leg as the one targeted in the previous step. To save time, you can target two different points twice each. This in effect "throws away" the second leg, because we only need Leg 1 to define the base line.
5. The angle displayed now means nothing, because Leg 2 was given "junk" for data points, so press ENTER to return to normal operating procedure.
6. To check if a second line is parallel to the base line, target one point on the line in question and zero the incremental datum (press X | Y). Now target a second point on the line.
7. Press, in order, POLAR, then ANGLE. What is displayed is the angle the two lines make with each other. The closer the number is to 0° or 180° the closer the lines are to being parallel.



This procedure will work on as many legs as you wish as long as you do not do another Multi-Point Angle calculation, for that would automatically establish a different base leg.

True Position Tolerance

If you have preprogrammed your datum memory for part inspection and you are displaying the deviation from a known dimension (tolerance) in Cartesian mode, by switching to Polar Mode the Cartesian tolerance will change to true position tolerance.

More accurately, what is displayed is the straight line distance from the datum memory to your current position.

Bolt Circle Calculation

You can calculate a bolt circle diameter with the Multi-Point Radius function (MPR) using the following steps:

a. Use the MPR function to find the centers of three of the bolt holes in the bolt circle, and store each of these centers in a different datum memory.

b. Press the RADIUS Key (*P3* will appear in the window). Recall the first point and press ENTER. *P3* will count down to *P2*.

c. Recall the next point and press ENTER.

d. Recall the last point and press ENTER. The best-fit bolt circle radius will appear in the X display.

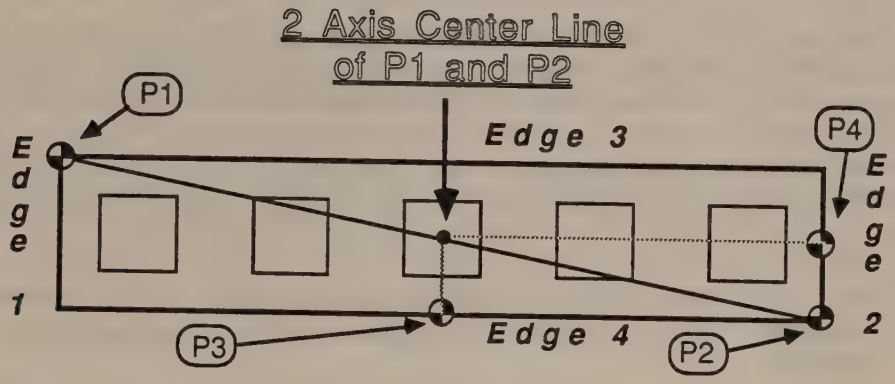
e. Press the "2" key. The best-fit bolt circle diameter will be displayed in X, and *d / A* will show in the Y display.

f. Press ENTER to return to normal operating procedure.

More than three bolt holes can be used in steps a-d by repeatedly pressing the RADIUS key in step b, and then recalling each point and pressing ENTER. Be sure to store each bolt hole radius in a different datum memory.

Center Line

The Quadra-Chek III has an easy to use center line function, which will find the center point of a line drawn through any two given points. This function will also enable you to find the center of any square or rectangular part as shown.



Follow these instructions to store the results of the Center Line function as either the incremental or absolute datum.

a. Place the cross hairs over one endpoint of the line being calculated (P1, in diagram), and press X | Y. This will set the incremental datum. If you wish to use the absolute datum, press INC/ABS | X | X | Y | Y.

b. Now move the cross hairs to the second endpoint of the line (P2) and press the "1" key on the QC-III's faceplate. ⊂ℓ (Center Line) will be displayed in the Y axis display window.

c. To calculate the center point, press ENTER. (To abort the center line function after it has been started, press CANCEL.) This center point becomes the new ∅, ∅, either incremental or absolute, depending upon the choice you made in step a. The distance from the center point is now displayed in the X and Y windows.

This procedure can also be done for a single axis (X or Y). If, for instance, you wished to find P3 on the above diagram, you would follow steps a and b as listed above. Now, you wish to find the mid-way point between the X coordinates of P1 and P2 but you wish to leave the Y coordinate as is. Press the "1" key, then the X key.

Similarly, to find P4, you would follow steps a and b, then press "1" then Y. This will find the mid-way Y coordinate between P1 and P2 without changing the X coordinate.

Note: This function can also be performed in Edge Mode. To do this, cross Edge 1 and zero the incremental X register. Then cross Edge 2 and press the '1' key followed by the X key. This finds the X coordinate half way between Edge 1 and Edge 2. Next, cross Edge 3 and zero the incremental Y register. Finally, cross Edge 4 and press '1' followed by the Y key. This finds the Y coordinate half way between edges 3 and 4.

Dist Cal

Dist Cal (Distance Calibration) allows you to fine tune your Edge Detector to properly read "fuzzy" or non-distinct edges. Be sure, however, that your image is as focused as possible, as this will lead to better accuracy.

This procedure should be done at least once per day, and every time you start to measure a new type of part that might cause different types of shadows to be projected. For instance, if you move from measuring a very flat part with distinct, sharp shadows to measuring a thick part with fuzzy edges, you should do the following calibration. Also, changing from highly reflective parts to dark, non-reflective parts (or vice-versa) should cause you to follow this procedure.

You will need a standard that approximates your part. If, for example, you are going to begin measuring thick, reflective parts, you should use a thick reflective standard.

Please note that this calibration works along the X (horizontal) axis only.

1. Press the CAL key until dISt CAL is displayed. Press Enter.
2. The X axis window will go blank, and the Y axis window will read dArk (dark). Move the screen sensor over a dark portion of the screen, and press ENTER.
3. The Y window will read LIGht (light). Move the screen sensor over a light portion of the screen, and press ENTER.
4. The Y display will read tArGEt (target). You now enter the horizontal (X axis) measure of your standard using the QC-III's numeric keypad, and press ENTER. Metric distances should be entered with the MM/IN light *on*.
5. The X axis will read dashes, and the Y axis will display try (try). You now move the screen sensor across the standard's image, crossing from one edge to the other (either left-to-right or right-to-left, whichever is more convenient).

6. The X display now shows a number (which should be close to the target value), and the Y display reads EntEr (enter). If this number is close enough to your target value, press CANCEL. AccEPt is displayed and the QC-III returns to normal operating procedure.

   If the number was not close enough, press ENTER and go to step 5.

7. Eventually correct (correct) will be displayed, and the QC-III will return to normal operating procedure.

If at any time no cAL (no calibration) is displayed, then your target value was too far from the standards actual measure. Press CANCEL and do an "Auto Cal" immediately. (See "Edge Detector Calibration" in Section One.)

Edit Cal and Print Cal

EdItcAL (Edit Edge Detector Calibration Factors) and Prt cAL (Print Edge Detector Calibration Factors) are two options that appear after pressing the CAL key enough consecutive times. These two features will help us help you if you ever have trouble with your edge detector. If, for some reason, your QC-III cannot recognize edge crossings, try each of these steps:

1. Make sure you are in Edge Mode or Auto Mode.
2. Do an auto cal (see "Edge Detector Calibration").
3. Do a dist cal, described above.

If your edge detector still refuses to work, give us a call here at Metronics, between 7 am and 6 pm EST, Monday through Thursday at (603) 622-0212. We will give you directions over the phone of how to use EdItcAL and Prt cAL. Using the information provided by EdItcAL and Prt cAL, we may be able to solve your problem over the phone.

Remote Programmable Keypad (Optional)

The Remote Keypad is an option for the Quadra-Chek III that allows the operator convenient access to all the functions of the QC-III from up to 9 feet away. The keypad has 7 programmable keys (letter keys A-G) and 1 dedicated key for programming the others (PRO). The keypad is much like user programmable keys on a computer terminal, where you can program a sequence of keys and recall the entire sequence with just one keypress.

For instance, you can create a "zero incremental display" key, by programming that key to be the same as X | Y. When you press the same key on the keypad, the commands X | Y will be carried out in order of entry. This will result in both displays showing *0.0000*, *0.0000*.

The memory used by the keypad is the same as is used for Set Up Mode so the definitions are permanent until you change them (not affected by power down). You have space available for 32 keypresses, but this space is shared by all 7 letter keys available for programming. This means you can have a different number of keypresses stored in each letter key, but the total cannot exceed 32. You can reprogram any key at any time and you can clear all program keys in Set Up Mode (see "Clear Program Keys" in Set Up Modes, NLEC, and Misc.).

You program the keypad as follows:

a. Press the program key on the keypad. *Pro* will appear in the Y display.
b. Press the letter key on keypad you wish to program.
c. Press the key sequence on the QC-III that you want programmed (i.e. X | Y | ENTER).
d. Press the program key. *Pro* will disappear and your key is now programmed.

To use your programmed key just press it, and the sequence you programmed for it will be carried out.

Often users program their keypads with Radius, Angle, Polar, Skew, and Enter functions (key A = RADIUS, etc.) and use some of the following sequences in the remaining keys.

X | Y	Zeros incremental display
RECALL | 0 | 0 | ENTER | INC/ABS |	
X | X | Y | Y | INC/ABS | X | Y	Start up
PRESET | X | 1 | . | 2 | 5 | ENTER	Repetitive preset
RECALL | RECALL | INC/ABS | PRINT	Sequential numbers on printout

Note: The programmable keys are not recursive, that is, you cannot call another program key from within the definition of another.

Error Messages

The Quadra-Chek III lets you know when a big mistake has occurred by displaying one of the following error codes.

Error 0 The counter is misreading the X axis scale. This may be caused by overslewing or dirt on the scales. To clear the error message, press any key. The QC-III will be returned to its initial status, with both the absolute and incremental memories cleared.

Error 1 The counter is misreading the Y axis scale. See *Error 0*.

Error 2 Points for Skew calibration have been targeted or entered incorrectly (e.g., two different points were not entered). Press any key to exit. Do the Skew calibration again to correct.

Error 3 You targeted or entered points for the Angle or Radius functions incorrectly (e.g., the points lie on parallel lines, or not enough distinct points were entered). Press any key to exit, then re-target and re-enter points.

Error 4 This message appears in the display during Polar Mode operation. It tells you that the vertex of the angle being calculated is too far out of measuring range to display its Polar coordinates. Press any key to exit. Counter will display the angle and Polar coordinates and will default to the distance from the target point number *P2* on Leg 2 instead of the vertex.

Error 5 You attempted to store a correction in NLEC that was too great for the system. Usually this means you did not advance to the proper station. Press any key to clear and continue.

Error 6 The edge detector is not calibrated properly. This error is most likely to occur when the edge detector is used for the very first time, before it has been calibrated. Press any key to exit, and then perform an *AutocAL* as described in "Edge Detection Calibration."

FAIL 1 The ROMs failed their checksum test. This could mean that your software has been corrupted. ***Call your QC-III dealer (or Metronics, Inc.) to report this error condition.*** Press ENTER to continue, but be advised that incorrect results might be generated.

FAIL 2 RAM error. Follow the same steps as for *FAIL 1*.

FuLL There are no more steps available for the programmable keypad. You can either delete another function entirely, or edit other functions to free up room for the function being entered.

oFLo This appears in the X or Y display and indicates that the number entered or calculated is too large for the display to handle (i.e., more than *99.99999* inches or *9999.999* mm).

Set Up Modes, NLEC, and Misc.

Set Up Operation 51
User Set Up 51
- User Set Up Mode Exit 52
- Change Count Direction 52
- Clear All 100 Datum Memory Points 52
- Clear Program Keys 52
- Serial Port Set Up 53
- Enter Dealer Set Up Mode 53

Dealer Set Up 54
- Auto Resolution Set Up 55
- Display Resolution 56
- Linear Error Compensation 57
- Prescaler 58
- NLEC Set Up 58
- Dealer Set Up Mode Exit 58
- Serial Port: RS-232 Pin Out 59
  - Handshake Description 59
  - Input Codes 59
  - Serial Port Output 60
  - Fast Download 61
  - Communications Program 62

Non Linear Error Correction 64
- A note on theory 64
- Before You Begin 65
- NLEC Calibration 67
- Edit Feature 70
- NLEC Report 70

Replacing Fuse 72
Changing Voltage Selection 72
Warranty Information 73
Service 73

Set Up Operation

There are two Set Up Modes, User Set Up and Dealer Set Up. User Set Up allows you to perform custom configuration of your QC-III. Dealer Set Up is used by qualified personnel only.

User Set Up

Note: This section is intended primarily for Quadra-Chek III users, to allow you to custom configure your QC-III.

You can alter the following things in User Set Up Mode:

1. Clear All Datum Memories (*00-99*)
2. Clear Programmable Keypad Memories
3. Reverse Reading Direction of X or Y Axis
4. RS-232 Port (Baud Rate, Word Length, Stop Bits, Parity)

All this can be done via the front panel controls. Do not open the QC-III (see WARNINGS).

To enter User Set Up Mode, press the "5" key on the numeric keypad. The Y display will be read *SEt UP*. Press ENTER to enter User Set Up Mode.

User Set Up Mode Exit

To exit User Set Up Mode at any time, press the CANCEL key. You should press this key after you've finished making all the changes you wish to make. When you exit User Set Up Mode all the changes you made will take effect.

Change Count Direction

H dIr (X direction) is displayed in the X axis window. If you wish to change the count direction for the X axis press ENTER, else press the "5" key to move to the next selection.

Y dIr (Y direction) is displayed in the X axis window. If you wish to change the count direction for the Y axis press ENTER, else press the "5" key to move to the next selection.

Clear All 100 Datum Memory Points

cLr (Clear Memory) is now displayed. If you wish to clear all 100 datum memories, press ENTER, else press "5" to continue to the next selection.

Clear Program Keys

cLr Pro (Clear Programming Steps) is now displayed. To clear all the programmable keys on the optional remote keypad, press ENTER, else press "5" to continue to the next selection.

Serial Port Set Up

PrInt (Printer Port) is now displayed. Press ENTER to start setting the serial port's characteristics, otherwise press the "5" to go on to the next selection.

Baud Rate

The Y display will show bAud, and the X display will show the current baud rate. To change the baud rate, press any key *except* the ENTER key. When the desired selection is made, press ENTER.

Baud Rates Available

50, 75, 110, 134, 150, 300, 600, 1200, 1800
2000, 2400, 3600, 4800, 7200, 9600, 19200

Parity

After pressing the ENTER key, PArITY will appear in the Y display. You can then select the desired parity by pressing any key other than ENTER. When the correct parity is displayed press ENTER.

Note: 0 = no parity, 1 = odd parity, 2 = even parity

Stopbits

Next you can select the number of Stopbits used. StoPbIt appears in the Y display.

Note: 1 = 1 stopbit, 11 = 1.5 stopbits, 2 = 2 stopbits, 0 = invalid

Word Length

Lastly, the word length is selected LEnGth will appear in the Y display. Lengths available are 5, 6, 7, and 8 data bits.

Enter Dealer Set Up Mode

SEt SYS (Adjust System Dependent Settings) is now displayed. Usually, you would press "5" here to skip over this choice, but if you wish to enter Dealer Set Up Mode, press ENTER. EntCodE (Enter Code) is displayed. Now key in the Entry Code provided for you. Refer to the section "Dealer Set Up" to continue.

If you entered an incorrect code, you will not be allowed into Dealer Set Up Mode.

Dealer Set Up

Note: This section is intended exclusively for Quadra-Chek III dealers, who have the responsibility of setting up your Quadra-Chek III to work with your optical comparator. If your QC-III has not been set up by your dealer, or if you change optical comparators, you may refer to this section for help.

You can alter the following things in Dealer Set Up Mode:

1. Encoder Resolution
2. Display Resolution
3. Linear Error Compensation
4. Programmable Keypad Memory Lockout
5. Prescaler
6. NLEC Settings

All this can be done via the front panel controls. Do not open the QC-III (see "Warnings").

Find the small envelope enclosed with this manual. Within the envelope you will find a number -- this is the number used to enter Dealer Set Up Mode.

To enter Dealer Set Up Mode from the normal operating mode, press the '5' key followed by ENTER to get into User Set Up Mode. Continue pressing the '5' key until *SEt SYS* is displayed, and press ENTER.

Now enter the number found in the envelope using the QC-III's numeric keypad. The X and Y displays will be filled with small zeros, and the upper right display will read *SU* for Set Up.

Please note: The directions on the next four pages assume that you are in Dealer Set Up Mode. Following the directions without being in Dealer Set Up Mode will only serve to confuse both you and the QC-III.

Auto Resolution Set Up

Check the last page of this manual and, if you find a Resolution Set Up Number there, follow the directions for this section, and skip the next two sections. Otherwise, skip this section and continue with "Encoder Resolution," below.

1. Press the ANGLE key.

2. Enter the number you found at the back of this manual using the QC-III's numeric keypad, and press ENTER.

This automatically sets up both the Encoder Resolution and Display Resolution for your particular scales.

Encoder Resolution

The QC-III can be configured to accept signals from many different encoders, but in order to display the right measurements, the QC-III must know the actual resolution of the encoder in use. Please note that encoders are either inch or metric and this must also be determined before entering this information. The example given is for metric scales with a resolution of 0.001 mm.

a. Press the STORE key. The X axis display will go blank.

b. Press the MM/IN key. The indicator light above the key should be *on*.

c. Key in the correct scale resolution using the numeric keypad. For this example, press "." followed by "001".

d. Lastly, press ENTER.

If you had wanted to enter an English resolution of 0.00005 inches, you would have skipped step b to keep the MM/IN light *off*, and entered ".00005" in step c.

Display Resolution

After entering the encoder resolution you must establish the display resolution. (Note: if you change the encoder resolution you must re-enter the display resolution). The display resolution tells the QC-III how you want your information displayed.

There are two display resolutions, one for metric and one for English. Not all applications require the extreme precision that the QC-III is capable of. The display resolution is selectable, so if you want the QC-III to round the display for you (to a coarser resolution) it will do so to your specifications.

For example, if you wish to see all of your metric measurements to the nearest 1/100th (0.01) of a millimeter, you would enter a metric display resolution of 0.01. This would cause a measurement of *0.9663* mm to be displayed as *0.97* because the QC-III rounded the measurement for you.

Each user should determine how many significant figures are relevant to their applications, and then enter this resolution by doing the following:

a. Press the RECALL key. The X axis display will go blank.

b. Make sure the MM/IN light is *off*.

c. Key in the correct inch display resolution using the numeric keypad. For example, for .00005 inches press "." followed by "00005".

d. Press ENTER.

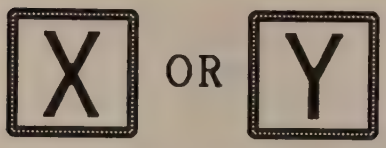
e. Press RECALL again.

f. Press the MM/IN key to light that indicator.

g. Key in the correct metric resolution using the numeric keypad (e.g., ".001" for .001 mm).

h. Press ENTER.

Linear Error Compensation



Linear error compensation allows you to correct for small errors in your comparator. This compensation will correct for linear errors only. If you have a more complex error problem, Non Linear Error Compensation (NLEC) is available as an option for the QC-III. A linear error is the same wherever you are on the travel of your machine -- if you find that in one inch you have 0.0002 in error, you will have 0.0012 in error in 6 inches.

To use linear error compensation you must first know a few things. Usually you would place a reference standard on the travel of the machine of approximately the same length as the maximum travel in that axis. You then zero the counter at the negative end of the standard (so that when you measure the standard you get a positive measurement) and measure the length of the standard. If your measurement is repeatedly too short or too long then you need to use linear error compensation.

From these measurements you have determined two important factors, the calibration distance (the length you are using to calibrate with) and the deviation (the difference between the measurement you should have seen and what you actually saw displayed). By entering this information into the memory of the QC-III, it can electronically compensate for this error.

One important caution: you must first clear the previous error compensation out of the axis you wish to correct before you attempt to calibrate that axis (see below). This is easily done by following these steps:

a. Press the X or Y axis key (the X display will go blank).

b. Key in the total travel that represents the calibrated distance (the actual length of your standard) for that axis. Example: for *6.0000* inches total travel press 6, then ".", then four zeros).

c. Press ENTER (the Y axis will go blank).

d. Key in the known deviation from true travel distance using the numeric keypad. For example, if there is a + *.001* inch deviation from true travel distance of *6.0000*, then press | . | 0 | 0 | 1 | +/- | ENTER

Note #1: The +/- key should be pressed only if counts need to be subtracted, not added.

Note #2: To clear (i.e. zero) linear error compensation, enter the true travel distance as above, then enter the known deviation as zero.

Prescaler

A prescaler is available for rotary encoders that provide finer than 1 micron resolution or to accommodate different resolution encoders on each axis. For example, J&L with DRC encoders, 1 count = 0.25 micron. Set up 1 micron scale resolution and use a prescaler of 0.25.

A decimal multiplier up to 7 digits long can be entered for either axis. Note that the decimal point is implied to be before the left-most digit although it is not displayed, i.e. 9842520 = .9842520. After pressing the RELATIVE key PrE SCL will appear in the Y display, select the axis you wish to prescale by pressing either X or Y or both X then Y. Next press the digits on the numeric keypad that correspond to your prescaler. When the correct number is entered press the ENTER key. Now the count from your encoders will be multiplied by this fraction before any further processing by the QC-III.

NLEC Set Up

WARNING: Do not press the ANGLE SELECT key while in Dealer Set Up Mode unless you have read the NLEC Set Up instructions. Pressing it will put you into NLEC Set Up. If you press it by mistake, press the RADIUS key to exit both Dealer and NLEC Set Up Modes. To re-enter Dealer Set Up Mode, refer to "Enter Dealer Set Up Mode" in this section.

Dealer Set Up Mode Exit

To exit Dealer Set Up Mode press the RADIUS key. When you exit Dealer Set Up Mode all the changes made in Dealer Set Up Mode will take effect.

Serial Port: RS-232 Pin Out

Pin No.	Description	Direction
2	Data In	Input
3	Data Out	Output
5	Handshake Out	Output
6	Handshake Out	Output
7	Signal GND	Common
8	Power On	Output (always high)
20	Handshake In	Input

Handshake Description

Pin 20 must be high voltage for the serial port to transmit.

Pins 5, 6 will go low voltage when input buffer is full. If sender does not stop transmitting when 5 or 6 is low, data transmitted to the serial port will be lost.

Input Codes

One-byte ASCII codes are equivalent to pressing keys on the QC-III. All alpha characters must be in the case (upper or lower) in which they are listed below.

Key	char	dec	hex	Key	char	dec	hex
X	'X'	88	58	+/-	'-'	45	2D
Y	'Y'	89	59	.	'.'	46	2E
Inc/Abs	'I'	73	49	0	'0'	48	30
In /Mm	'M'	77	4D	1	'1'	49	31
Enter	cr	13	0D	2	'2'	50	32
Radius	'R'	82	52	3	'3'	51	33
Angle	'A'	65	41	4	'4'	52	34
Polar	'0'	79	4F	5	'5'	53	35
Ang Sel	'L'	76	4C	6	'6'	54	36
Skew	'S'	83	53	7	'7'	55	37
Relative				8	'8'	56	38
(Delta)	'D'	68	44	9	'9'	57	39
Store	'T'	84	54	Fast			
Recall	'E'	69	45	Download	'F'	70	46
Print	'P'	80	50	Zero	'Z'	90	5A
Cal	'C'	67	43	Cancel	'N'	78	4E
Edge/+	'G'	71	47	Auto	'U'	85	55
Preset	'B'	66	42	Comp.Print	'p'	112	70

Serial Port Output

Each small box below represents a one byte character: sp=space, cr=carriage return, ***d***=display digit. The d's in the line starting with 'm' are the digits in the memory display window. Note also that "INC" will be output when the QC-III is in Incremental Mode, and "ABS" will be output when in Absolute Mode.

The 'in' appears when in the Inch Mode, and 'mm' when in metric. The minus sign will appear when the display is negative and a space will appear when positive. If not all seven displays are used (leading or trailing blanking), those displays will be spaces.

When in Polar Mode the lower example is the format used where r = x display, and a = y display (vector and angle).

Cartesian Format:

cr														
m	sp	*d*	*d*	,	I	N	C	cr						
x	sp	-	*d*	*d*	.	*d*	*d*	*d*	*d*	*d*	sp	i	n	cr
y	sp	sp	*d*	*d*	.	*d*	*d*	*d*	*d*	*d*	sp	i	n	cr
cr														

Polar Format:

cr															
m	sp	*d*	*d*	,	A	B	S	cr							
r	sp	-	*d*	*d*	*d*	.	*d*	*d*	*d*	*d*	sp	m	m	cr	
a	sp	-	*d*	*d*	*d*	.	*d*	*d*	.	*d*	*d*	sp	d	e	g	cr
cr															

Fast Download

The Fast Download function is accessible only through the RS-232 interface. This function provides a means to get position information at the greatest possible speed. When you send a Fast Download command to the QC-III, it responds by sending the contents of the counters directly out the RS-232 port in binary format. The counters are read directly and the output is not influenced by any processing -- no linear, nonlinear, or skew correction.

The purpose of this feature is mainly for users who wish to use the QC-III as feedback for a motor drive system. When you request the Fast Download function by sending an upper case 'F' on the RS-232 interface the QC-III will "lock up" (the display will not update any more) until you send a character different from 'S' or press a key. You must request a download with an 'F' every time you want to read the counters.

The format of the output is:

$|S_T|D_X|D_X|D_X|D_Y|D_Y|D_Y|C_S|$

S_T = start byte = "S" = 53 hex
D_X = Data X channel: Most significant byte first, 2's complement format
D_Y = Data Y channel: Most significant byte first, 2's complement format
C_S = Checksum = sum D_X thru D_Y mod 256

In conjunction with the Fast Download function there is also a way to zero the counters. By sending the QC-III an upper case 'Z' over the RS-232 interface the counters will both be reset to zero. Note however that by directly zeroing the counters this way, *you will disturb any absolute zero you have previously established and you will upset NLEC 00 if you have NLEC installed.* Using the Zero function is only recommended if you are not using any of the other functions of the QC-III.

Communications Program
QC-III <------> IBM computer

This section will explain how to create an interface between an IBM Personal Computer and a QC-III. Please use the BASIC language program enclosed with your IBM as a basis for developing a specific program to suit your needs.

You will need 2 items in addition to the program listed below.

a. A cable from the PC to the QC-III is "straight through", that is, pin 2 to pin 2 etc. The cable uses pins 2, 3, 7, and 20.

b. IBM or "compatible" computer.

The program may be used to receive data from the QC-III. If you want to send commands to the QC-III, refer to the serial port documentation in this manual.

```
100   '            Open Communications Port
105   '
110   ' Modify line 120 if required to change the number of the port.
115   ' The baud rate may also be modified here if the QC-III baud rate has
116   ' been changed from the default rate of 600.
117   '
120   open "com1: 600,N,8,2,RS,DS" as #1
125   ' 8 bits, no parity, 2 stop bits, com port 1 on PC
130   '
140   '
150   ' It is easy to send commands from the PC to the QC-III.
160   ' See owners manual for details on command codes and use:
170   '    print #1, "[command]"
175   '
180   ' The following loop will read continuously from the QC-III's port.
190   ' The results will be displayed on the PC's screen.
200   '
201   gosub 5000
202   goto 201
1000  end
```

(Continued on next page)

IBM is a registered trademark of International Business Machines.
PC is a trademark of International Business Machines.

```
4995  '
4996  '
4997  '
5000  '        This is the General Read Subroutine
5005  '
5100  ' The format of the messages is always the same
5105  '
5200  ' Format is        <CR>
5210  '                [*] <text> <CR>
5220  '                 <measurement data> <CR>
5230  '                 <measurement data> <CR>
5240  '               <CR>
5250  '
5260  ' The "*" appears in line 2 if the "p"rint command has been received
5270  ' from an external source (such as the PC).
5280  '
5300  line input #1, A$ : print
5310  line input #1, H$ : print H$
5320  line input #1, X$
5325  X! = val(mid$(X$,2%,11%))
5330  print X$
5335  print using "####.#####"; x!
5340  line input #1, Y$
5345  y! = val(mid$(Y$,2%,11%))
5350  print y$
5355  print using "####.#####"; y!
5360  line input #1, A$ : print
5370  return
9999  end
```

Non Linear Error Correction (NLEC)

Please note: this section is intended for those who have purchased the NLEC option. You may skip it if you do not have NLEC. It is also primarily intended for informational purposes only, since your dealer will have electronically compensated your comparator when he installed your QC-III. However, you may use this section to do periodic realignments as necessary.

As you know, optical comparators tend to need adjustment now and then. Wear and tear reduces their accuracy. In order to correct this error, the QC-III has an optional feature called NLEC. In effect, NLEC lets you map out the errors inherent in your comparator. The QC-III then remembers where these errors are, and each time you pass through them, it adds or subtracts the appropriate error factor automatically.

A note on theory

NLEC is different from our standard linear error compensation. Linear error compensation is an incremental error compensation. With linear error compensation if you move one inch along the X or Y axis the linear error compensation will add or subtract the appropriate correction for one inch of travel. This occurs whenever you make a measurement no matter where on the travel you make it.

NLEC works by dividing your optical comparator's area into a grid of up to 20 x 20 blocks. You choose the number and the size of the grids. Each grid area has its own compensation factor built in, and the QC-III remembers each factor. This optional feature allows you to electronically compensate for any inaccuracies that your optical comparator may have developed.

The electronic correction grid must be physically tied to the machine travel -- for example, the correction for the lower left corner of travel is only valid for that corner. In order to realign this electronic grid with the physical travel of your machine you must assign a landmark point on the machine. This point (called "NLEC 00") can be anywhere that is conveniently repeated when you turn on the QC-III.

Once NLEC is installed on your machine you must return to this same point and press ENTER every time you turn on your QC-III. This action will cause the NLEC map to register on the travel of your machine correctly. For convenience the QC-III can be left on continuously, eliminating the need for re-establishing NLEC 00. However if power failure should occur, NLEC 00 must be re-established.

Note that the following calibration procedure must be done in *Cross Hairs Mode*. If the light above the EDGE/+ key is on, press that button once.

Before You Begin

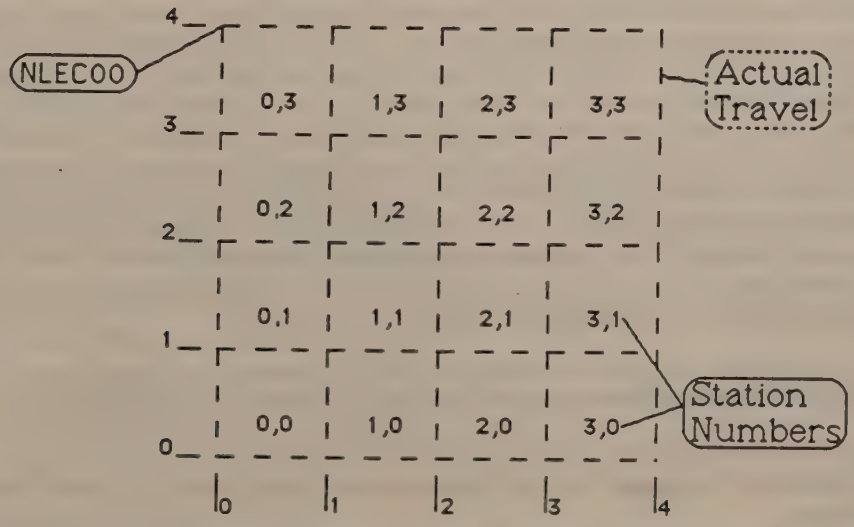
There is some planning you must do before you start the calibration procedure. First, you must determine the size and number of your correction blocks. This is dependent on a number of factors:

1. The grid size of your calibration grid (if your grid has 0.1" spacing then the smallest NLEC grid size you can use is 0.1).

2. The amount of usable travel on your measuring instrument. Example: if you are calibrating a CMM with 20 x 20 inch travel then the smallest NLEC grid size you can use is 1.0".

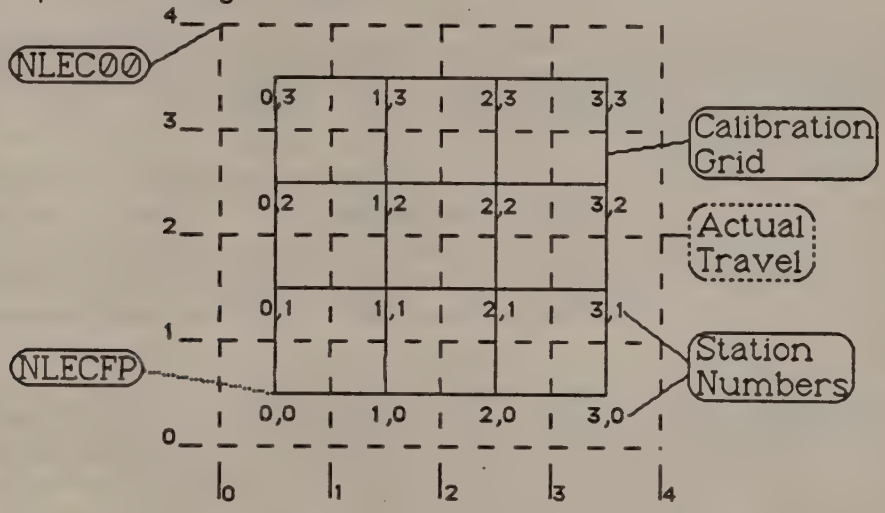
3. The amount of inaccuracy of your measuring instrument. For example, if you are using a calibration standard with 10 lines to the inch, and the machine inaccuracy in one inch of travel is less than the actual display resolution, it would be unnecessary to calibrate in less than 1 inch blocks. This will save you a lot of time in the total calibration process.

The second thing you need to plan for is the reference point that establishes the location of the correction map the "NLEC 00" point. As discussed above, this point can be any convenient place on the travel that is repeatable. For our illustration we will assume that there is a hard stop in the upper left corner of the travel that would be easy to return to when we started up our QC-III, so we have chosen that point for our NLEC 00 point. Before we continue let's look at an illustration. For our discussion we will use a travel of 4 x 4 inches.



The illustration on the preceding page shows the limit of the travel of our phantom machine. We have determined the NLEC grid size to be one inch. The numbers in the blocks are identifying numbers used when editing.

Another consideration when planning for NLEC calibration is the position of the actual calibration grid you will use to determine the error in your machine. The NLEC feature determines error from the center of the individual grid areas. This makes sense, since the center gives the best "average" of the area's error factor. So when you calibrate points, in reality you calibrate the centers. Look at the illustration below and you will see that the calibration grid is shifted up and to the right 1/2 inch.



Note also that the grid required is only 3 x 3 inches. This is because we are using the edges of the calibration grid and get four lines per side.

The next thing you must plan for is a point called "NLECFP". This point is the First Point that you calibrate when using the normal automatic calibration procedure. This point must be in the "most negative" corner of the travel. "Most negative" means if you move your stage to the left and the distance displayed is decreasing then your NLECFP will be near the side where you run out of travel going in that direction. The same holds true for the Y axis. In our example the point on the travel that we would start from is at 0.5 x 0.5 in. on our travel. If we moved to the center of any block from there the value displayed would increase in positive increments. This point is at 0.5 x 0.5 is because we want to calibrate the centers of our blocks as mentioned before. You can use your QC-III to help you position your calibration grid, by moving to the usable limit of your machine in the negative directions (near NLEC 00) and zeroing your displays and moving 1/2 of the step size you have selected (in our example 0.5 X 0.5 in. because our step size is 1 x 1 in.). Once you have moved to this spot manually adjust your calibration standard to align with the cross hairs on the screen.

You should also clear linear error compensation in Set Up Mode (see the section on Dealer Set Up Mode) before you start calibrating with NLEC or the calibration will be incorrect.

A final precaution is to be very careful about aligning the grid with at least one axis of your machine. This is necessary because the NLEC feature will quite happily "build in" the skew of a misplaced standard.

NLEC Calibration

Note: If you have not read all precautions above do not continue.

To access the functions described on the following pages, you must first enter Dealer Set Up Mode. To do this, first turn on your QC-III. Both the X and Y displays should read "0." Next, press the "5", followed by ENTER to get into User Set Up Mode. Press the "5" key until SEt 595 is displayed, then press ENTER.

Using the QC-III's numeric keypad, enter the numeric code found in the small envelope at the back of this manual. If you followed the steps precisely and entered the correct code, you are now in Dealer Set Up Mode. Both the X and the Y displays should now read 00.00000.

To get into NLEC Set Up Mode, press the ANGLE SELECT key. You will see nL appear in the memory window. You are now in NLEC Set Up and will remain there until the RADIUS key is pressed or power is removed. The ANGLE SELECT key also turns NLEC on and off. You just pressed the ANGLE SELECT key to get here but if you press it while in NLEC Set Up the display will read nLEc on or nLEcoFF. To select between these two, press any key except ENTER. When the desired selection is made press ENTER. You will exit Set Up Mode and the displays will read zeros.

The first step is to establish grid size. How many separate areas do you want to have, each with its own compensation factor? Let's say we want a grid of 4 x 4 equal sections, or a total of sixteen square areas. To establish a 4 x 4 grid:

a. Press the SKEW key. The X display will go blank. This tells the QC-III that it's time to establish the grid.

b. Then press the following buttons in this order: 4, ENTER. Upon pressing ENTER, the Y display will blank.

c. Now establish the grid in the Y dimension. Press 4, then ENTER. The displays will read 0, 0.

Now that you have established the number of separate areas on your grid, it's time to establish the size of the grids -- the distance between each successive area.

a. Start by pressing the POLAR key. The X display will go blank; you may ignore the Y display for now. Let's arbitrarily choose the dimensions of each grid area as 1 inch by 1 inch.

b. Next, on the numeric keypad, press "1", and then ENTER. The X display will read *1.0000*, and the Y will go blank.

c. Now, do the same thing for the Y dimension. Press "1" and then ENTER. The Y display will now read *1.0000*.

Having established the grid, we must now determine the NLEC 00 point of the comparator. This will be the point that serves as a landmark for the comparator, the initial reference point it uses to determine where it is. This point can be any convenient point. If your comparator has a hard stop at the far left, for example, that would be a good start up (0, 0) point.

Remember that this calibration procedure must be done in *Cross Hairs Mode*. If the light above the EDGE/+ key is on, press that button once.

To establish this point, do the following:

a. Press the ANGLE key. The Y display will read *nLEc 00*.

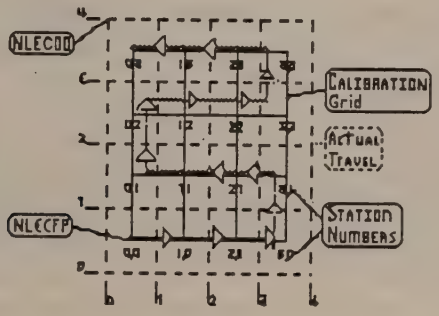
b. Move the machine to the desired 0, 0 reference point and press the ENTER key. The Y display will now read *nLEcFP*, indicating that you should next enter the first calibration point on the grid.

Move the cross hairs to the first point in the calibration sequence. When you have targeted that point press enter. You will see *1.0000* inches displayed, prompting you to move 1 inch to your next point of calibration.

You should move until the displays read 0, 0. This should put the cross hairs very near the next calibration point. If your machine was in perfect calibration you would find your self directly over the next calibration point. If you find you are in slight misalignment with the reference standard then move the cross hairs until they are in perfect alignment with the standard. The displays will show the amount of correction necessary at that point to compensate for the mechanical error in your machine.

When you are correctly positioned press ENTER. The QC-III will store this correction factor in its memory, subtracting it automatically whenever the optical comparator travels in this area of the grid.

This procedure is continued to the right another 1 inch, and then up 1 inch, and then to the left 1 inch, in a snake-like pattern, until all points have been calibrated and entered (in this example, there would be 16 points to calibrate).



When you get to the fourth point in our example (in the first row, all the way to the right), the QC-III will begin to compensate distances in the Y direction (before, we were moving along the X axis). So now the Y display, rather than the X, will be the one that changes.

When you get to the last point (number 16), and you move the comparator so that the X and Y displays read zero, you will find yourself back at the starting point: 0.5, 0.5. This completes the correction procedure. You can exit by pressing the RADIUS key, or, if you have a printer connected to your QC-III, you can print out the calibration report by pressing the PRINT key.

Edit Feature

The NLEC function includes an edit feature that lets you make changes in what you've programmed. The RELATIVE button turns the edit feature on and off. When you calibrated your machine each block was assigned a identifying number. These numbers are called station numbers (see illustration). If you find that after time only a few stations have gone out of alignment then you could determine the error in just those blocks and change them in edit mode, without having to go through the whole calibration procedure again.

You enter the edit mode from NLEC Set Up Mode by pressing the RELATIVE key. The Relative light will go on. You can then select the station you want by pressing the RECALL key. The RECALL key is a toggle switch for the display, switching between station numbers and error for that station. When you have station numbers displayed you can preset to any station you want. For example, to choose station (2, 1), you would press X | 2 | ENTER then Y | 1 | ENTER. The displays would show *2*, *1*. If you press RECALL again the error at that station would be displayed (the same as on the printout).

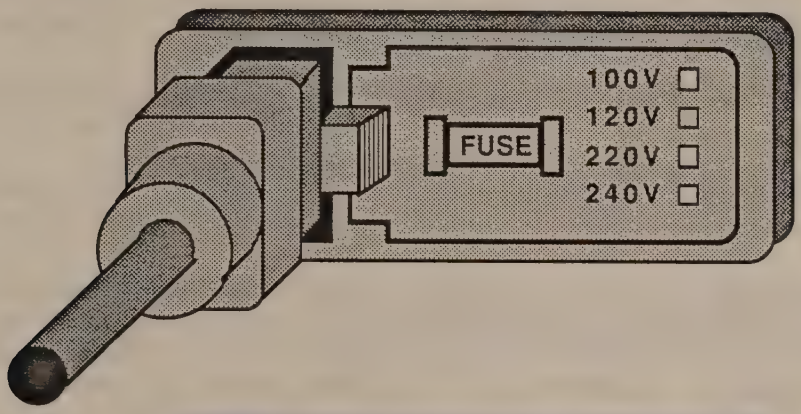
You can now change the display to show the new correction desired. Do this by pressing the X key and presetting in the desired correction (e.g. for *.0005*" correction press the X key then | . | 0 | 0 | 0 | 5 | ENTER). Do the same for the y axis by pressing the Y key and presetting in the desired correction. To save the new correction you must press the STORE key, if you don't your change will be ignored and not saved. You can do this again for more points if you wish or exit using the RADIUS key.

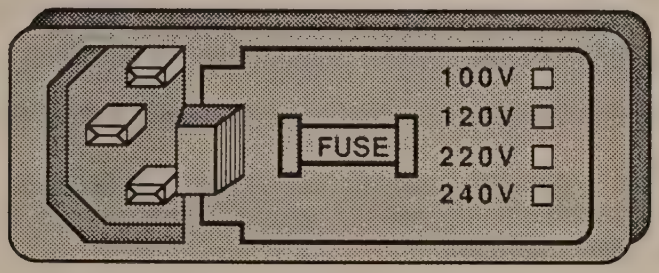
NLEC Report

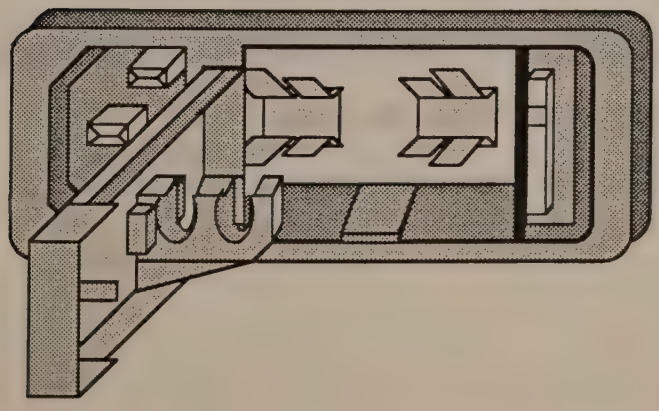
The QC-III will print out a complete table of each grid point along with its X and Y compensation factors. Press the PRINT key while the QC-III is in NLEC Set Up Mode.

Replacing Fuse and Changing Voltage Selection

The Quadra-Chek III is designed to operate from international power sources. The primary power module on the rear of the unit provides connection for the power cord plus a housing for the fuse, and switching capability to allow operation from various power sources. See the figures below, as well as the text on the next page.







Replacing Fuse

- Remove power cord.
- Push to the left on the 'thumb notch' to open fuse chamber.
- Remove fuse.
- Replace fuse with a fuse of the appropriate current rating.
- **100 or 120 volt, 47 to 63 HZ operation, use 0.5A fuse.**
- **220 or 240 volt, 47 to 63 HZ operation, use 0.25A fuse.**

Changing Voltage Selection

- Remove power cord.
- Push to the left on the 'thumb notch' to open fuse chamber.
- Slide safety cover to the left exposing voltage selection cord.

> **NOTE: The voltage that is currently selected is the one that reads correctly while looking at the primary power module.**

- To change the voltage selection, remove the voltage selection card. A small screwdriver or needle nose pliers both work well.
- Re-install the card so that the desired voltage is correct reading.
- Close the safety cover and insert the power cord.
- The unit is now ready for operation from the new voltage.

Warranty Information
Limited Warranty

Metronics, Inc. warrants your new Quadra-Chek III to be free from defects in parts and materials for a period of one year from the date of delivery, and will repair or replace, at its sole option, any defective unit brought to its attention during that period.

Metronics, Inc. makes no implied warranty that the Quadra-Chek III will be suitable for your particular purpose.

Some states do not allow the exclusion of implied warranties or limited warranties, so the above may not apply to you.

In no event will Metronics, Inc. be liable to you for any damages, including lost profits, lost savings, or other incidental or consequential damages arising out of the use or inability to use this product, even if Metronics, Inc. or an authorized Metronics dealer has been advised of the possibility of such damages, or for any claim by any other party.

Some states do not allow the limitation or exclusion of liability for incidental or consequential damages so the above limitation or exclusion may not apply to you.

Service

In the event that your Quadra-Chek III needs service, please contact your QC-III dealer, or Metronics directly if you bought your machine from Metronics.

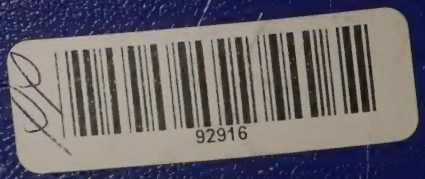
Index

absolute 14, 32
absolute datum 10, 12, 14, 15, 37
Absolute Mode 15, 60
aligned 19
an incremental 32
angle 22, 23, 49
ANGLE SELECT 23, 36
Auto Edge Mode 11, 17, 19, 20, 22, 37, 43
Auto Resolution Set Up Number 76
axis zero reset 14, 15
base line 43
Baud Rate 53
bolt circle 44
calibration 17
Calibration Mode 12
CANCEL 31
Cartesian 35
center 20, 21
center line 45
Change direction 52
circle 20, 21, 28, 29
circumference 20
Configuration Modes 12
Count Direction 13
Cross Hair Mode 33
cross hairs 16, 17
Cross Hairs Mode 11, 13, 14, 17, 25, 28, 37
datum memory 21, 23, 26
datum point 37
Dealer Set Up 51, 54, 58
Dealer Set Up Mode 54
diameter 21, 44
Display Modes 11, 12
Display Resolution 56
distcal 46
Edge Detection 10, 16
edge detector 17, 25, 46, 49
Edge Mode 11, 17, 28, 29, 37
edit 70
encoder 55, 58
Encoder Resolution 55
error messages 49
Fast Download 61
fuse 71, 72
Handshake 59
Inch Mode 60
incremental 14, 15
incremental datum 10, 12, 14, 15, 23, 37
Incremental Mode 15, 60
Incremental/Absolute 12
Index 74
Input Codes 59
inspection 40, 44
Keypad 48, 52
Linear Error Compensation 57
memory 21, 38, 39
misreading scale 49
MM/IN 12
modes 11
MP Angle 31
MPA 22
MPR 20, 21, 28, 29, 31, 44
Multi-Point Angle 22
Multi-Point Radius 17, 20, 31, 44
NLEC 4, 49, 57, 58, 61, 64, 65, 66, 67, 70
NLEC 00 64, 65, 66, 68
NLEC Set Up 58
NLEC Set Up Mode 67, 70
nlecfp 68

Non Linear Error Compensation 64
origin points 14
parallel 43
Parity 53
Part Programming 40
POLAR 23, 35
Polar coordinates 49
Polar Mode 12, 17, 21, 25, 28, 29, 60
Polar Select 36
position memories 38
power sources 71
prescaler 58
preset 32, 33
print 21, 23, 69, 70
PRO 48
program 38, 48, 49
QC-III Quickie Slide 16, 22, 29
radius 20, 21, 26, 28, 29, 31, 38, 42, 49
RECALL 42
reference sensor 16
Relative 26, 27, 34
RS-232 59, 61
screen sensor 16, 17, 46
Serial Port 53, 60
Set Up 4, 48, 51
Set Up Mode 12, 66, 67
skew 19, 31, 42, 49
slide 13
Stopbits 53
Storage Sequence 39
STORE 38, 39
Targeting Mode 17
Targeting Modes 11, 17
tolerance 38, 44
true position tolerance 44
User Set Up 51
User Set Up Mode 51, 52
Voltage 71, 72
warnings 5
Word Length 53

Auto Resolution Set Up Number for Your Scales:

___00	___09
___01	___10
___02	___11
___03	___12
___04	___13
___05	___14
___06	___90
___07	___91
___08	___92


92916